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H. B. WALKER, President   RAYMOND OLNEY, Secretary-Treasurer

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The Object and Scope of A. S. A. E. Activities

THE American Society of Agricultural Engineers was organized in December, 1907, at the University of Wisconsin by a group of instructors in agricultural engineering from several state agricultural colleges, who felt the need of an organization for the exchange of ideas and otherwise to promote the advancement of agricultural engineering. The object of the Society, as defined by the Constitution, is "to promote the art and science of engineering as applied to agriculture, the principal means of which shall be the holding of meetings for the presentation and discussion of professional papers and social intercourse, and the general dissemination of information by the publication and distribution of its papers, discussions, etc."

The membership of the Society represents all phases of agricultural engineering, including the educational, professional, industrial, and commercial fields.

The scope of the Society's activities embraces both the technical and economic phases of the application of engineering to agriculture, and is comprehended in the following general headings:

(a) Farm Power and Operating Equipment—power, implements, machines, and related equipment.

(b) Farm Structures—buildings and other structures and related equipment.

(c) Farm Sanitation—water supply; sewage disposal; lighting, heating, and ventilating of farm buildings, and related equipment.

(d) Land Reclamation—drainage, irrigation, land clearing, etc., and related structures and equipment.

(e) Educational—teaching, extension, and research methods, etc., employed in the agricultural engineering field.

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AGRICULTURAL ENGINEERING

The Journal of Engineering as Applied to Agriculture

RAYMOND OLNEY, Editor

Vol. 6 JANUARY, 1925 No. 1

EDITORIALS

Nationalize Reclamation

TOO many farms, vanishing timber supply, abandoned farms, and bankrupt irrigation and drainage projects, have been prominent in the headlines since 1919. A combination of circumstances has subjected extensive reclamation in general to criticism. The very things which brought about these things in the past are a challenge to the engineer who must prevent such mistakes in the reclamation of the future. The engineer must not only plan a wise future policy, but he must correct the mistakes of the past.

Out of some 973 million acres of so-called potential arable land in the United States, 365 million acres have been selected and reclaimed for harvested crops. Some was wisely selected but much was settled with little judgment and foresight. Reclamation since its early crude beginnings has been largely the "game" of the promoter. "Engineering" has too often been subserved to immediate money getting.

The natural desire to break away from easy civilization, the restlessness and desire for independence, has made easy the work of the land promoter. No consideration was given to the needs of agricultural production. Little attention was paid to the inherent quality of the soil, accessibility or nearness to market. The hunger for land and farm homes made possible the promotion of great projects and the sale of vast areas to would-be farmers. Land has been sold and cleared of stumps and stones but because of location, soil, or other conditions it cannot compete with better land and return a fair living to its owner and operator. Lands have been included in irrigation projects and vast sums spent in erection of dams and works not justified under existing conditions. Drainage districts are often staggering under the load of unwise reclamation methods.

This land hunger and other causes led our forefathers to explore and settle as pioneers in new areas sometimes no more adaptable than the larger promoted projects. Sometimes such settlements were started because the pioneer could get no farther. Physical hardships or lack of money compelled him to stop short of his expectations. All this was not necessarily bad but the factors for success were often accidental.

Now the mad ruch has crossed the country, stopping where temporary opportunity offered or circumstances forced; passing good in the search for better. Abandonment of thousands, largely of these poorer acres, is taking place and must continue until a balanced production is secured which will enable the poor farmer to exist and the "average" farmer to live. Future necessity for expansion of our crop area is certain. Acreage expansion in form of reclamation projects will be justified to take the place of poor lands abandoned.

It is the agricultural engineer's job to work out and direct a national policy of reclamation which will involve a readjustment. He will make easier the further abandonment of lands obviously submarginal. He must admit candidly that much of such land exists. He will point the way to more efficient operations which may save loss on some near-marginal lands. But, chiefly, he will aid in the selection and operation of those lands which should be brought to maximum production. In doing this, ways may be developed to utilize the poorer lands in some way not for farms so they will pay their overhead cost of ownership.

Such a national policy seems to involve:

(1) Continued selection of best agricultural lands which can survive in productive competition. (There must be a willingness on the part of agricultural engineers to cooperate with other agencies, notably soils specialists, foresters, and others in the management of farms and use of land.)

(2) Diversion of remaining good lands, of which there are vast areas, to forestry or other use. (For some time to come much good land may well be used for forestry. Increased production on land now in farms and the reclamation of only the best idle lands will meet the needs of an increasing population.)

(3) Abandonment of poor lands (poor because of climate, soil, distance from market, topography, etc.) until such time as the population or other national expediency justifies the further shifting of groups.

Some of the lands, poorer so-called from an agricultural viewpoint, may well be used for recreational purposes. The very features making lands undesirable for other purposes may make them useful for recreation.

The agricultural engineer, however, may well realize that a few successive unfavorable crop years with present falling acreage and a hundred thousand of new domestic population each month will so affect the economic situation that more extensive reclamation and colonization will be demanded. The forced abandonment of poor lands, which never should have been put to use, is rapidly bringing conditions to a point where either an increase in acreage will be necessary or extraordinary efficiency of operation becomes necessary. Even now agricultural exports barely exceed our agricultural imports and production per capita is steadily decreasing.

JOHN SWENEHART

Geared to His Job

ON April 10, 1924, a commission of special advisors appointed by Secretary of Interior Work, made recommendations for a new policy of reclamation administration by the federal government. The salient features of these recommendations were as follows:

1. Scientific classification and valuation of land in existing projects.
2. Aid and direction in agricultural development.
3. Project management by water users.
4. Scientific and adequate plan of repayment of construction costs.

Most of the recommendations of this commission of advisors have been made law by Congress. The Kendrick Lill, introduced December 30, 1924, will, if passed, complete the acceptance by Congress of the fact finuers' recommendations.

Agricultural engineers should recognize the new policy of the Bureau of Reclamation and of Congress as an opportunity for putting into practical service the principles of agricultural engineering. Probably the greatest need of agricultural engineers today is the creation of institutions through which the agricultural engineer may be geared to his job. Research and technical ability in strictly engineering phases are essential, but until organization makes possible the employment of agricultural engineering ability through rural institutions, the profession will fall short of its objective.

DAVID WEEKS

Efficiently Filling the Silo*

By F. W. Duffee

Mem. A. S. A. E. Associate Professor of Agricultural Engineering, University of Wisconsin

THE ensilage cutter tests conducted by the agricultural engineering department of the University of Wisconsin last year, uncovered several lines of investigation, some of which we have followed up this year. We wish to emphasize that most of the data and conclusions which we have are not offered as final, but subject to future modifications, as additional factors are discovered and measured.

Six manufacturers cooperated with us in furnishing nine machines and having engineers present during the tests.

An explanation here is in order as to why only those who participated in the tests last year, were invited this year. In the first place, we were not able to complete our new dynamometer engine until very late. In fact, if the season had not been late we would not have been able to do more than about one week's work. We felt that due to certain discrepancies of last year, these manufacturers had first claim on our time. As it was, we were just able to complete the tests on those machines entered.

The investigations included the following:

1. Securing data to aid in arriving at an accurate method of rating the capacity of cutter.
2. Uniform rating of ensilage cutter sizes.
3. The relation between speed, capacity and horsepower.
4. The limits of elevation on all machines.
5. A study of the air pressure at the bottom of the blower pipe.
6. A comparison of using a large and small pipe on one machine.
7. The relation between length of cut and horsepower requirements.
8. The relation between capacity and efficiency.
9. Effect of removing the distributor pipe on horsepower.
10. The effect of a ball and socket joint in the blower pipe.
11. The effect of the knife angle on the nature of the cut.

EQUIPMENT FOR THE TESTS

Power and Recording Mechanism. A 55-horsepower Waukesha engine (5 inch bore by 6¼ inch stroke) was built into a dynamometer similar to the Ohio belt dynamometer. The engine is hung in a counterbalanced cradle (Fig. 9) which in turn is mounted on ball bearings. The torque of the engine was recorded by a Gulley traction dynamometer, (Fig. 10) and a permanent record made on a strip of paper.

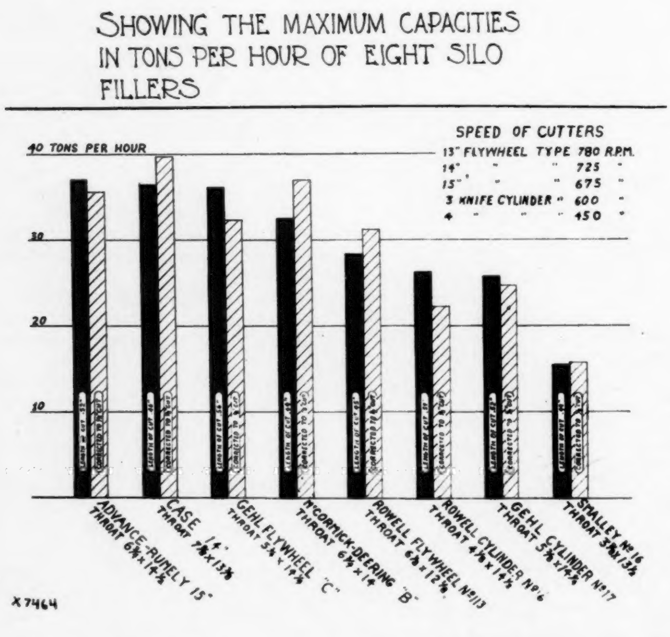
Engine revolutions; the horsepower record; cutter revolutions; and time were all controlled electrically through a master switch, (Fig. 10) so that all of these instruments began recording exactly together and at exactly the time a load was started, and stopped exactly at the end of the load. The performance of the entire outfit was highly satisfactory in every respect, except for the integrator on the Gulley, and gave every appearance of functioning accurately at all times. The dynamometer was calibrated on a Prony brake and found to be very accurate.

PROCEDURE

A test code was formulated with the idea of oprating all the cutters under as nearly uniform and comparable conditions as possible, both as to speed and capacity.

One to one and a half loads of corn were cut for each test.

*Paper presented at a meeting of the Farm Power and Machinery Division of the American Society of Agricultural Engineers, Chicago, December 3, 1924.



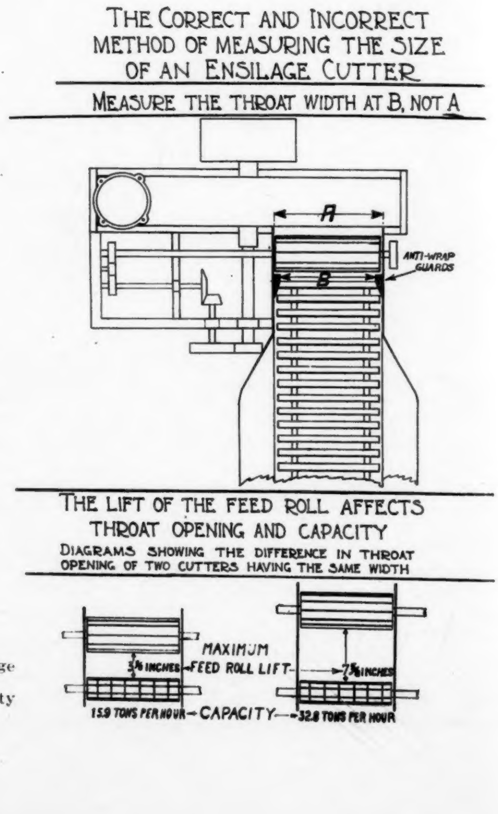
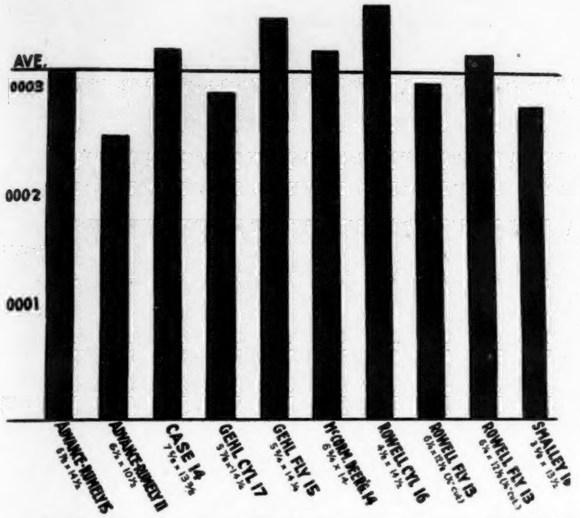


Fig 1. (Above) This chart shows the maximum capacities of eight ensilage cutters, corrected to uniform speed and cut

Fig. 2. (Right) Method of measuring ensilage cutter to determine capacity



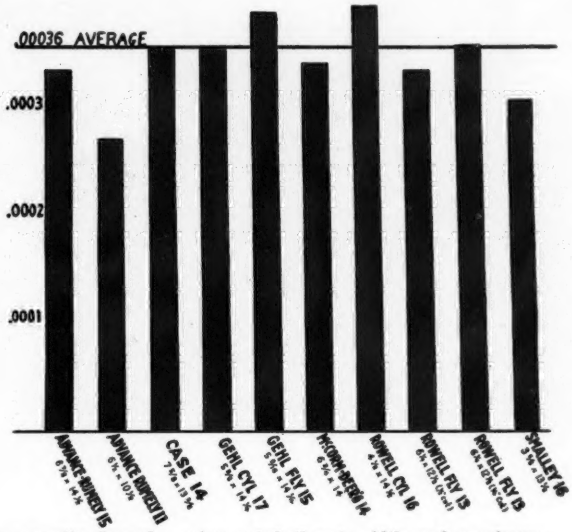


Fig. 3. (Left) This shows graphically the vaue of "K" in the capacity formula, using rated throat width and maximum height of several silo fillers

Fig. 4. (Right) The value of "K" in the capacity formula, using the minimum throat width, which seems to be more nearly the correct dimension

and the test repeated until approximately the correct desired speed and capacity were secured.

In practically all cases feeding was done by three or four men from two wagons, so as to secure uniform feeding as well as maximum capacity on certain tests.

Three standard test speeds were selected, the high speed being about the average present rated speed, intermediate speed 20 per cent slower and low speed 40 per cent slower. Smaller machines were operated correspondingly faster than larger machines, so as to maintain practically constant peripheral velocity of the fan on the ssumption that this is necessary to secure uniform elevation. The first test was to determine maximum capacity at intermediate speed. The second test was at intermediate speed and at 75 per cent of maximum capacity which was considered to be a good working capacity. This particular capacity we have called a normal capacity.

The two tests were conducted on high speed, one at a normal capacity and one at 75 per cent maximum for that speed.

This gives us tests at three speeds, the capacity remaining the same. Also tests at three speeds with the capacity in proportion to the speed and about 75 per cent of maximum in each case.

The final test was to determine the minimum speed required to elevate 75 feet, operating at approximately 75 per cent of maximum capacity. This last series of tests was conducted within a period of three days, under very uniform conditions so as to be quite comparable.

Special tests were conducted which will be discussed later.

RESULTS

Maximum Capacity of Cutters. The maximum capacity of each machine was determined at the intermediate standard speed, the machine being fed as uniformly as possible to the limit. In most if not all cases a very slight additional amount of corn would put excessive strains on the feeding mechanism. In fact, practically all the machines were broken during this test, or rather in attempting to arrive at the proper capacity to be considered a maximum.

The results of this test indicate: (1) That a formula for capacity can be established that will be reasonably accurate; (2) that machines have much greater capacity than is ordinarily considered, and (3) that 15 or 16 inch flywheel machines and 18 or 20-inch cylinder machines have much more capacity at present rated speed than any ordinary crew of men can supply, proving that larger machines are unnecessary. In fact, machines of these sizes can be operated at speeds approximately 40 per cent slower than present recommended speeds and still have sufficient capacity for ordinary requirements resulting in much greater efficiency.

The chart (Fig. 1) shows the maximum capacities of eight cutters. In order to be more readily comparable the capacities have been corrected to uniform speeds on the solid bars, and again corrected for length of cut on the sectional bars.

The maximum capacity of two good men throwing off is ordinarily under twenty tons, and in most cases about 16 tons per hour. The little Rowell 13-inch flywheel machine, running at 780 r. p. m. and working at an average of 60 per cent maximum capacity will cut all the corn two men will handle. It is important, however, that the speeds shown here be reduced in the interest of efficiency. However, the two 15-inch and two 14-inch machines with speeds reduced 35 to 40 per cent would still have ample capacity for two men feeding and working hard.

Measuring Throat Area. This data on maximum capacity gives us the necessary information to determine whether a formula can be written for calculating capacity, and if so the proper method of measuring the size of the cutter and determining a constant for the formula.

The upper half of the diagram (Fig. 2) shows the two different methods of measuring the throat width. It has been our contention that the proper place to measure width is at "B" when anti-wrap guards are employed.

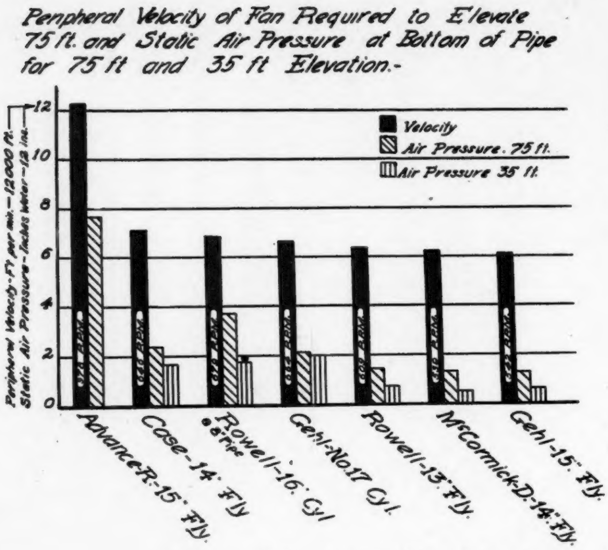
The lift of the feed roll (Fig. 2) naturally must also be taken into consideration In fact the lift affects capacity more than width, as one-half-inch additional lift will affect capacity as much as 1½ or 2 inches difference in width. Further, if the rule is adhered to of keeping the peripheral velocity constant, and the different sizes are built in the same proportions, the difference in width does not affect capacity at all.

A point for consideration in measuring throat lift is the nature of the surface of the feed rolls. Some are notched in such a way as to increase the total effective lift somewhat over the net lift as measured between closest points. Some comb-shaped rolls are effective from one-third to one-half their total depth, and this point has been given consideration in the following calculations:

Formula for Rating Capacity. All of the factors which we consider of prime importance in determining capacity appear as follows in a formula:

$$\text{Capacity in tons per hour} = W \times H \times L \times N \times R \times K$$

W=Width of throat in inches measured at narrowest point



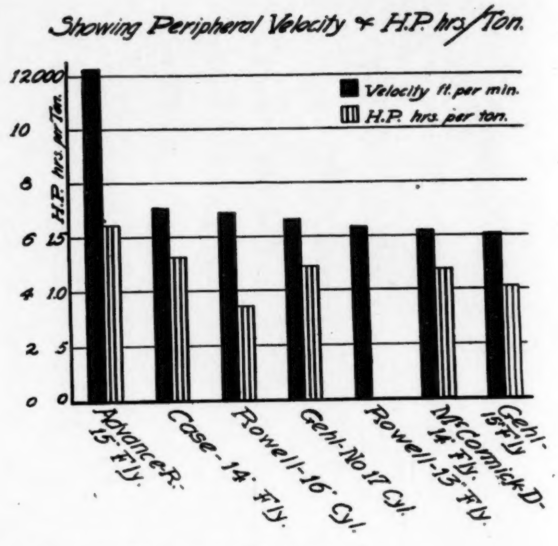


Fig. 5. (Left) A comparison of the elevating efficiency of silo fillers in the Wisconsin tests
Fig. 6. (Right) The relation between elevating efficiency and horsepower efficiency

H = Height of throat in inches
L = Length of cut expressed decimally
N = Number of knives
R = Speed in revolutions per minute
K = A constant to be determined experimentally (found to be 0.00036)

The chart (Fig. 3) represents graphically the value of K in the above formula, using the present rated width of throat.

There is no reason why the Rumely 11-inch machine should be so low; we probably did not feed it to capacity due to elevating trouble which I will discuss later. The Smalley was cutting very dry corn which accounts for its being low.

Fig. 4 shows the value of K when using the narrowest throat dimension; the values are considerably more uniform than in the former chart, eliminating the Rumely 11-inch and the Smalley. The Gehl machine was cutting somewhat heavier and more mature corn which probably a little more than offset a slightly frosted condition. We are unable to offer any explanation as to why the Rowell cylinder machine is so high.

The maximum variation is about 6 per cent with most of them closer. Additional carefully checked tests, we believe, would bring even closer results, probably with th result of raising the factor (0.00036) slightly.

We believe this practically proves our contention that the narrowest part of the throat is the proper dimension to measure in indicating size.

Other factors which modify this formula are moisture content of corn and relative growth, whether large and heavy or small and light. Our work has been done with a good average growth of fodder and ears, averaging about 75 per cent water.

A working capacity for a day's run of 40 to 60 per cent of the maximum given above would probably represent good average farm conditions, and some such figure as this should be established for rating cutters for the trade. This is a matter I would like to see discussed and possibly a plan outlined for trying the rating out in an experimental way with farmers, before adopting any final ratings.

However, the formula as it now stands we believe is reasonably accurate for comparative purposes.

Swivel Joint in Blower Pipe. The Advance-Rumely machines came equipped with ball and socket swivel joints at the bottom of the pipe to permit adjusting the pipe to the silo. The joint was 5½ inches long and had an inside maximum diameter of 8¼ inches, the pipe being 6½ inches. In operation it was observed that the entire pipe was lifted up frequently, as much as the slack in the joint would allow; this was undoubtedly due to silage striking the sides of the ball.

The minimum speed that would elevate into a 42-foot silo with this joint in was 575 r. p. m. With the joint out it elevated 75 per cent of its maximum capacity nicely at 487 r. p. m., or 15 per cent slower, and probably would have elevated at a slightly slower speed.

Effect on Power of Using Only Two Sections of Distributer. The Gehl flywheel machine was operated with only two lengths of distributer attached, as the animal husbandry department at the University of Wisconsin desired to investigate the advisability of filling a silo without tramping. If removing all but two sections of distributer affected the power in any way, it would be by increasing or decreasing the air pressure at the bottom of the blower pipe.

The Gehl deflector is quite long and open, and the top section of distributor is large so that it would not seem likely that additional distributer in this case would affect the power. We have made a careful study of the air pressures of this machine and of others, for 35-foot elevation and for 75-foot elevation, where they should be comparable, and there is no evidence of more than a very slight effect, if any, except at the high speeds, and here the difference is small. When compared with the difference in pressure and power for 75-foot elevation against 10-foot elevation, we believe the absence of distributer cannot at the most have affected the power more than 2 per cnt. Obsrvations also indicate that minus atmospheric pressure prevails at the first and second distributor joints.

Pressure at bottom of pipe—inches of water

Cutter	35-foot pipe Low Speed	Intermediate Speed	High Speed	75-foot pipe
Gehl	0.38	0.61	0.75	1.25
I. H. C.	0.42	0.99	1.20	1.33
Rowell	0.57	0.87	1.30	1.45

A Comparison of Large and Small Pipe. In this subject we are dealing with a decided variable. I am a firm believer that there is one size of pipe that is right for a particular machine, and either larger or smaller will not work as well, to the extent of increasing power, or interfering with elevation.

At the close of last season the Case machine was changed over from an 8-inch to a 7-inch pipe. This was done by changing the bottom section of pipe which is about 2 feet long, rectangular at the bottom and round at the top. The results of this change have been to increase the power re-

Comparison of 7-inch and 8-inch Pipe on the Case ensilage cutter

Size pipe	R. p. m. of cutter	Tons per hour	Static air pressure	Horsepower-hours per ton	percent increase for small pipe
Small pipe	612	22.50	1.506	1.486	0.75
Large pipe	628	23.25	0.881	1.475	14.00
" "	637	23.57	0.869	1.304	
Small pipe	505	15.93	1.100	1.313	2.4
Large pipe	510	15.35	0.531	1.282	

The speed required to elevate 75 feet was increased from 632 r. p. m. to 646 r. p. m.

quirements slightly and decrease the elevating efficiency a trifle.

This cutter has a very wide clearance between the side of the fan and the housing, being 1½ inches on the knife side and ⅜ inch on the pulley side. If this clearance is reduced, it will probably increase the disadvantage of the small pipe quite markedly.

On the Rowell flywheel machine the size of pipe has been reduced from 7 to 6½ inches since last year. The efficiency of this machine is lower than last year, and I believe that this may be at least partially attributed to the smaller pipe. If we had taken air pressure last year, we could probably make a more definite statement about this.

A comparison of this and last year's figures on the Rowell fly wheel machine reveals that the elevating deficiency of last year has been overcome, and this has no doubt increased the horsepower requirements somewhat, due to the fact that very efficient elevation and very light power requirements are not compatible according to our investigations. We cannot sacrifice elevating efficiency, and must look for other means of increasing power efficiency; however, there may be considerable difference in the power required for elevating, even though they be equally efficient in lifting the silage.

Effect of Knife Angle on Quality and Uniformity of Cut. The Rumely 15-inch cutter came with knives inclined 6° 43′ from the plane of rotation. After a few loads were run through the engineer asked to be allowed to change the angle, and did so reducing it to 2° 41′ by placing ½-inch washers under the back ends of the knife supports. The difference between the front and back edges of the knife was 6/32 inch after change and 15/32 inch before the change. The knife is 4 inches wide. Before straightening up the knife the machine mushed the corn considerably, the cut was not uniform and even, and mushy material oozed from all the lower joints. After the knives were set up straighter these troubles seemed to be entirely overcome.

The Relation Between Length of Cut and Horsepower. In order to get data on this subject tests were conducted on two machines. The results are shown in the table below:

first graduallly reduced until the machine clogged and then increased just enough to prevent clogging.

Fig. 5 shows graphically the lowest peripheral velocity of the fan that would elevate 75 feet, also the static air pressure for this elevation, and the air pressure for 35-foot elevation at a speed and capacity as nearly comparable as was available from the data.

To my mind, the point of prime importance is the air pressure, which is lowest for the most efficient machine (Figs. 5 and 6), increasing quite uniformly with the increase in peripheral velocity. This would certainly prove that a cutter throws more than it blows, and that very little air pressure is needed; in fact, we believe that the pressure can be reduced to practically atmospheric with but little effect on elevation. This can be done by restricting the air intake, and should result in a saving of power, as the only reason which can be ascribed to causing increased power for higher elevations is back pressure or increased air pressure at the discharge point of the fan.

The Case machine shows a quite markedly lower air pressure, due undoubtedly to the fact previously mentioned of wide side clearance on the fan.

How Air Pressure Affects Power. Further tests conducted this year substantiate our work of last year that a high elevation requires more power at the same speed and capacity than low elevation. If this is true, it can only be caused by greater air pressure.

The elevation tests indicate that very little pressure is needed ordinarily, so we believe that if we could reduce the pressure to atmospheric, we would have a lighter running cutter. A study of all the tests this year tends to bear out the theory that low pressure means lighter running. We believe that attaching adjustable wind blinds to both sides of the fan housing is desirable, from the standpoint of power saving, could be easily and readily done, and would require very little attention in the field. Instructions could be stenciled on it to keep it closed or as nearly so as possible to still secure elevation. It would of course have to be opened up some for high silos, especially if the cutter was being operated at a slow speed; also for dry corn.

We expect to investigate this feature next year.

Cutters	Cut -inch	R. p. m of cutter	Tons per hour	Horsepower	Horsepower-hours per ton	percent increase for shorter cut
Rowell 13-inch	0.454	676	23.12	25.45	1.101	
	0.29	685	15.44	20.97	1.358	23.40
	0.454	556	13.45	13.41	0.997	
	0.29	552	8.12	9.22	1.135	14.65
	0.454	780	21.40	28.97	1.354	
	0.29	798	14.28	24.06	1.685	2.45
Gehl flywheel 15-inch	0.558	479	26.12	16.55	0.634	
	0.285	468	13.38	11.11	0.830	30.90

NOTE: The tonnages in each pair of tests are closely proportional to the length of cut, therefore comparable on a working basis.

Measuring the Elevating Efficiency. The code was devised with the idea of measuring the limitations of a cutter, and one of the most important is elevation. As a result of our work of last year, we recommended a general reduction of speed ratings in order to save power. A few tests were conducted to determine at what heights and speeds a machine would elevate; these supported our contention that slower speeds were possible as well as desirable. The maximum capacity tests of this year further prove the possibility, and in order to get further accurate data, seven of the nine machines were checked up on a 75-foot elevation test.

Great care was exercised to determine the lowest speed that appeared to be sure of elevation. In most cases a full load of corn was cut for a test, the machine being fed to about 75 per cent of maximum capacity. The speed was

Reduce Speed for Efficiency. We have come to what appears to be the most important part of all this work, the relation between speed, capacity and horsepower.

The real capacity of the machine is proportional to the speed. On large machines, however, the men are usually the limiting factor, and in their haste and effort to keep the table filled and the machine working to capacity, they actually handle less corn per hour, than they do when the machine is operated at a slower speed.

The report contains figures on all machines at different speeds, and the increased efficiency at slower speeds is very marked in all cases.

In order to test this out to the limit, one of the larger machines was operated through a wide range of speeds, the minimum being about the slowest that would elevate into a 35-foot silo.

The curves (Fig. 7) show this better than it can be expressed in words.

The capacity is in all cases very closely proportional to the speed.

The horsepower curve is much more abrupt than the capacity curve. In fact, doubling the speed and capacity, in this case means increasing the horsepower required seven times.

We were able to cut 16 tons per hour, with approximately 5 horsepower or only a little over ⅓ horsepower-hour per ton, at the slowest speed. The average of all machines last year at the rated speed was 1.3 horsepower-hours per ton, the average this year is but little better. This brings us to the following conclusions:

(1) This proves we can get excellent efficiency at slow speed.
(2) We have proved the machine can be designed to elevate at slow speed.
(3) The quality of cutting is excellent if the knives are set quite close.
(4) The effect of slower speeds on wear and tear need not be discussed.
(5) But how shall we get the desired capacity in a medium sized machine?

The answer to this question I believe lies in a four-knife, eight-fan blade machine.

Let us take a case from the curve and assume a speed of 450 r. p. m. with a 42 to 44-inch fan, which I believe can be designed to elevate successfully under practically any and all conditions. Adding another knife will increase the capacity 33⅓ per cent, or up to 27 tons per hour, the total horsepower would certainly not be increased more than an equal amount, probably less, rseulting in equal or even higher efficiency.

I am advised that four-knife machines have been tabooed in the past, for various reasons, one being elevation, but I would call your attention to the record of the Silver Clean-Cut (11-inch cutter) tested last year, which had a remarkable capacity for so small a machine, ran light, elevated well, and did excellent work in every respect.

We believe that there is a good future for such a machine of 14 or 15-inch size, probably not over 14-inch. Its capacity at a speed of 550 r. p. m. would be enormous, and this speed is at present slower than any recommended speeds for this size, and we believe as stated before that a still slower speed can be used.

One or two are already interested in this to the extent of building experimental machines next year. If this is done we will have definite data on the subject by next winter.

Effect of Capacity Upon Efficiency. In studying the previous chart the question naturally arises as to whether the same general efficiency relations will hold if the capacity were reduced for the higher speed, which undoubtedly would be the case in practical operation. The tendency would be to keep the capacity constant at all speeds, above a certain point.

The results of varying the capacity at a comparatively slow speed are shown on the chart (Fig. 8). There are some irregularities here, but the general tendency is quite distinctly toward higher efficiency with greater capacity.

A comparative study of tests No. 1 vs. No. 2; No. 3 vs. No. 6; No. 4 vs. No. 5 on all machines reveals that in most cases the efficiency is affected but little by moderate variations in capacity with a slight tendency toward better efficiency with higher capacity, in a majority of cases.

Effect of High Elevation on Power Requirements. A test was conducted on the McCormick-Deering Type B (14-inch) to determine the power required for 75-foot elevation as compared to 10-foot elevation, with the following results:

Height of Silo	Cutter r. p. m.	Tons per hour	Average Horsepower	Horsepower-hours per ton
10 feet	529	14.64	20.90	1.429
75 feet	533	13.35	20.60	1.543

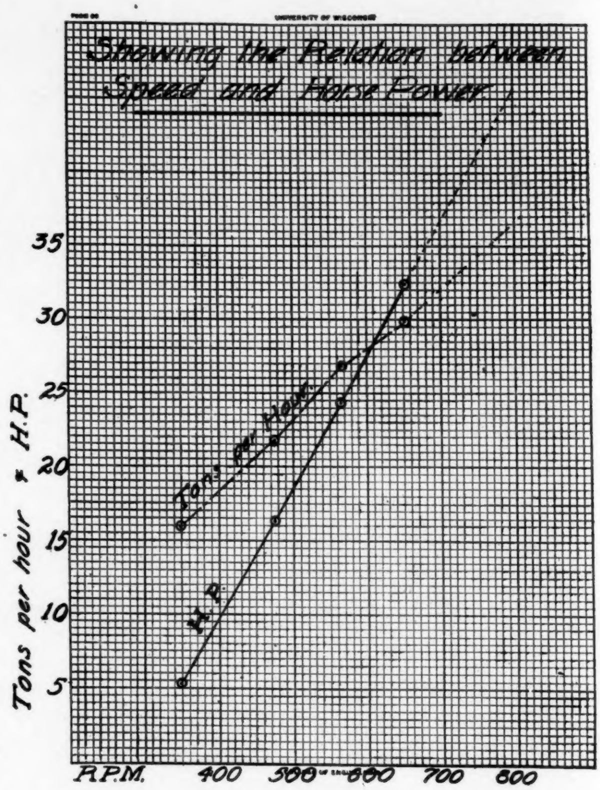
Increase for high pipe 8.05 per cent.

This checks very closely with practically all of our results of last year.

At high speed and low capacity it is likely the results would be reversed.

FINAL RECOMMENDATIONS

We trust this report will be accepted as a progress report rather than a completed one. Much of the information is incomplete; on the other hand, some of it we believe is quite conclusive at the present time. I refer especially



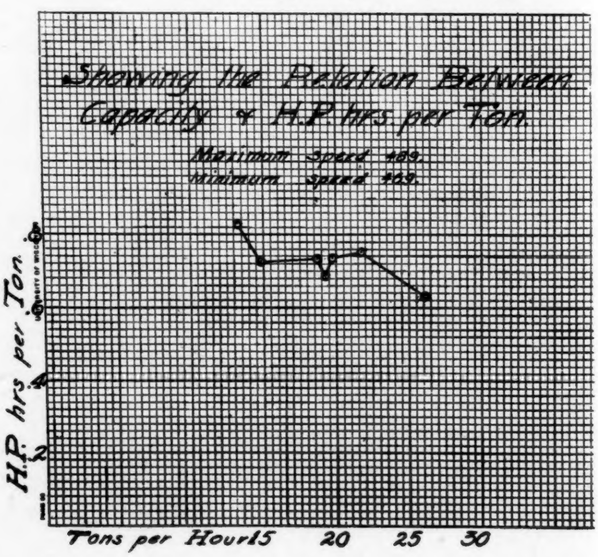
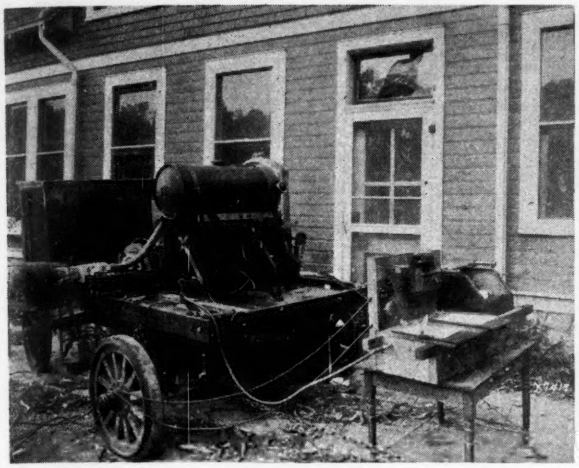


Fig. 7. (Top) These curves show that doubling the speed also doubles the capacity, but that seven times as much horsepower will be required to drive the cutter

Fig. 8. (Bottom) This curve shows that greater efficiency is secured by operating the cutter well up to capacity



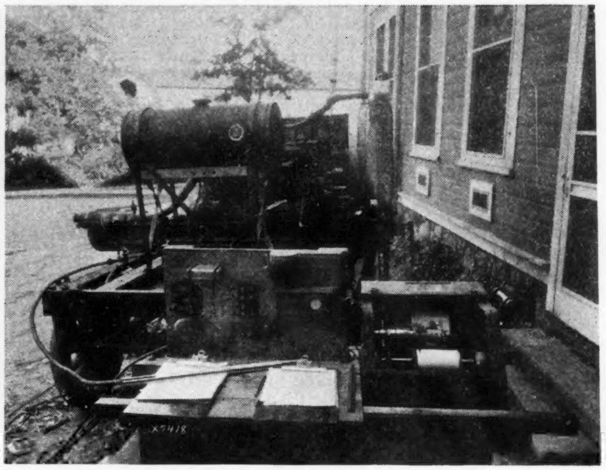


Fig. 9. (Left) A view of the recording belt dynamometer. The recording mechanism is located on a separate table to avoid the vibration of the engine

Fig. 10. (Right) This shows the recording mechanism of the Gulley dynamometer, and the instrument board carrying stop watch, machine revolution counter, signal bell and electric control switches

to the relation between speed and efficiency, and hope that every manufacturer will give this come consideration. The day of inefficient farm machinery is passing rapidly, and the farmer is demanding more economical operations in all lines. We cannot immediately adopt very slow speeds, but I believe that in most cases the recommendations can be lowered somewhat, and future developments should be toward still lower speeds.

I urge that we set ¾ horsepower-hour per ton for the ½-inch cut as our goal, and I sincerely hope that every machine will be able to get in under this figure inside of a few years.

The University of Wisconsin has spent several thousand dollars in the last four years on this investigation, with the idea of helping Wisconsin farmers to feed their dairy cows for less money, and we are after real results.

We wish to thank those manufacturers who have cooperated with us, for their assistance, and assure you of our desire to be of further assistance wherever possible, to all concerned.

We would also especially urge that manufacturers stencil on all machines the size as follows:

Minimum throat width x throat height........................
Number of knives............... Rated speed................
Example:
13½ x 6
3 Knives Rated speed--600-700 r. p. m.

Code for Testing Silage Cutters

Formulated by the Agricultural Engineering Department of the University of Wisconsin.

1. Maximum Capacity Test. Determination of maximum capacity at a predetermined standard speed which will be the same for all machines of a size, and will be the intermediate speed as listed for the variable speed tests given below. A normal average capacity will be calculated from this, and will be about 75 per cent of the above determined capacity. Horsepower will be recorded.

2. Horsepower Test. Rated speed, manufacturer's rating, normal elevation, normal capacity. If the manufacturer's rated speed coincides closely with one of the standard test speeds listed under the variable speed tests for the particular size, it is desirable to use that speed only.

3. Variable Speed Tests. Horsepower tests for normal elevation at three predetermined standard speeds as follows:

(a) Flywheel Cutters
10-inch...........700...........875...........1050 r. p. m.
11-inch...........625...........775........... 925 r. p. m.
12-inch...........575...........725........... 870 r. p. m.
13-inch...........540...........675........... 810 r. p. m.
14-inch...........500...........625........... 750 r. p. m.
15-inch...........475...........580........... 675 r. p. m.
16-inch...........440...........550........... 660 r. p. m.

(b) Cylinder Cutters
500...........625...........750 r. p. m for 3-knife machines
375...........475...........575 r. p. m. for 4-knife machines

Fan and cylinder speed ratio to be constant and as regularly recommended by the manufacturer.

Also record static pressure for all tests.

4. Elevation Test. Minimum speed to elevate 75 feet operating at 75 per cent maximum capacity for the speed. Also determine horsepower and static pressure at bottom of pipe.

Cylinder machines using normal, recommended, cylinder to fan speed ratio.

(a) Green corn
(b) Wilted corn

5. (To be added to future tests.) Tests at different lengths of cut so as to establish a correction formula for ½-inch cut or establish curves through the ½-inch cut.

Discussion

Mr. Gehl: Prof. Duffee has covered the ground very thoroughly in his report which he has presented this morning, and, if we watched carefully, we can appreciate the amount of effort that was really required to conduct such tests and conduct them as thoroughly and with the idea of getting such information as we really wanted. For that reason I believe that this Society is very fortunate in having a man like Prof. Duffee to carry on such work.

On behalf of the silo manufacturers I venture to say that this is the best information that any implement manufacturer has ever secured from an outside source, and I believe that at this time it is very proper to discuss the rated capacity according to the throat area of the silo fillers. In the past, we cylinder cutter manufacturers used to beieve that it was very hard to adopt a constant that would apply and do justice to both types of cutters, because we always were able to get a greater capacity per square inch on our cylinder cutters than we were able to get on our flywheel cutters, considering the speed. We recommend a maximum speed of 700 r. p. m. on the cylinder cutter, but the fact is that they very seldom are being run faster than 550 to 600 r. p. m. The flywheel cutters, in the majority of cases, are being run above 650 r. p. m. to about 800 r. p. m. In our last year's test at the University of Wisconsin, we found that by running a machine 500 r. p. m. we could get the same capacity as we would if it were run at 700 r. p. m. That goes to show that on the average sized machine when run 700 r. p. m. or more it cannot be fed as regular as if it were running 500 or 550 r. p. m. This is where, I believe, we were misled when we thought a greater capacity could be gotten on a cylinder cutter per square inch than on the flywheel cutter; therefore, I believe that a constant could be adopted which would apply to both types as well.

This report also brings out the fact that when a machine is run at a speed beyond 600 r. p. m. the power increases per ton considerably. We have been recommending too high a speed on our

flywheel cutters, which has been a detriment to the farmer as well as to the machine, because it took a great deal heavier power equipment to run the machine at such a high speed, whereas if it were run at a slower speed, the farmer could very easily get along with a great deal lighter power and save the machine considerably.

Just yesterday I attended a meeting of silo manufacturers and during their discussion the fact was brought out several times that in some states the cost of filling a silo is too high, and the question was asked why it was that in the state of Wisconsin all the silos are being filled all the time whereas in some other states a good many silos are filled only part of the time. It was also brought out that some of the farmers in other states are of the impression that the cost of filling a silo is too great. According to this report, we can easily see where we can reduce the cost of filling a silo considerably by getting the right size silo filler and running it at the right speed and having the right power equipment. In this connection, I would like to bring out the fact that in Wisconsin the majority of the farmers are filling their own silos with their own power and equipment and their own help; therefore, I believe that the future of the silo filler depends upon a filler that is capable of handling one full bundle such as the binder makes, without a man at the feed table, with power such as is available on the average farm. As soon as we have accomplished this, we have something with which we can fill a silo very economically.

I would like to ask Prof. Duffee if I am right when I state that a constant can be adopted that will apply to both types of machines, that is, a constant to determine the capacity in tons per square inch of throat area considering the speed and length of cut.

Prof. Duffee: The factor is quite close. The speed is involved in the formula. The factor is quite accurate for all types, and I believe that if we conducted further careful experiments, repeating until the very maximum in capacity was reached, there would be still less variation, but the value of the factor would increase slightly.

Mr. Gehl: This brings out the fact that we cylinder cutter manufacturers were misled when we thought it was impossible to adopt a constant that should apply to both types of machines. If a machine is being run at about 550 r. p. m. with one-half inch cut, the machine can be fed more regular, that is, more to its capacity, and in that way more capacity can be secured per square inch of throat area than if the machine is being run at a higher speed.

From this report, the Society has secured some very good material, which can be used as a basis for a standard that can be adopted for determining the capacity, and I would suggest that it be presented to the silo filler department of the National Association of Farm Equipment Manufacturers.

Mr. Blodgett: The matter of speed and rating is very important. The old remedy of the builders for elevating was speed, and that has been set aside by Prof. Duffee and others. We can now elevate with low speed. That is his ambition in the tests, and I believe we can reduce this speed even more, as he has suggested through the tests and efforts that they are putting forth now at the University of Wisconsin. These tests should not be ignored, for they are giving us the best help we have ever had; we are getting more out of these tests, I believe, than we really appreciate It has been a revelation to some of us, and the fact that we have exploded the theory that we must, in order to elevate, speed up the fan, is one good thing, and the efforts of Prof. Duffee and other agricultural experiment stations are going to hep us, and we should turn in and do the best we can.

Mr. Condit: I notice the knives sometimes hit the cutter bar on an angle, as they come down; others hit like that, and some are curved. I would like to know if that has any effect.

Prof. Duffee: I am not in a position to say. I don't even have an opinion. There was a tendency last year called to my attention by Mr. Merwin, that the curved knife left the kernels on the ear quite uniformly, and that the straight knife had more tendency to knock them off. I did not however make any close comparison.

Mr. Condit: Some of the knives will cut away and some cut towards the center. I am wondering it that had any effect.

Prof Duffee: I don't know. If anyone is sufficiently interested I will be very glad if they will prepare an experimental machine and we will find out.

Mr. Gehl: In answering that I would say that the idea is to force the cut material to the outer edge of the blower immediately after it is cut and by having a knife in the wheel, which cuts inward instead of outward, it would offer resistance to the cut material, whereas a knife which cuts outward has a tendency to throw the feed outward also and thereby get it to the outer rim of the blower a great deal sooner, which naturally eliminates some unnecessary power.

If you will give me just a few minutes more, I would like to say a few words. A year ago when Prof. Duffee conducted tests at the University of Wisconsin, many things were pointed out to us manufacturers which were entirely contrary to our ideas. We all took our machines to this test with the idea of having the best machine of them all, and I believe this motto applies quite well: "There is only one good woman in this world and that is my wife." Any silo filler manufacturer, after he has designed and improved a silo filler, naturally feels the same way about it. These tests were not conducted with that idea.

They were for the benefit of the farmer, as well as the manufacturer and if any manufacturer believes he has a good machine, it is very well for him to have it tested, because if the machine proves to be inefficient, the quicker he gets to know this the better he is off, and the better the showing will be on the balance sheet at the end of the year. I believe Mr. Merwin will agree with me on this subject. For that reason we manufacturers should feel perfectly willing to have our machines tested in such a way, and if they are not up to standard they can be improved so that they will do the work successfully.

Mr. Mainland: As far as these tests have been conducted, I believe we have as complete and as accurate information as it is reasonably possible to get, and from my own observation I think these tests are accurate enough so that anyone can put reliance on them, but there is another phase of the subject that I would like to see tested out and which possibly has as much bearing on the performance of ensilage cutters as those on which the tests have been conducted. We would like to see further tests made on fan clearance and fan wing angles. We believe these are factors that affect the performance of a cutter just as much as any of the factors on which tests have been conducted. Possibly something has been done along this line but we have no knowledge of such tests if any have been made. Here is a field for further in-

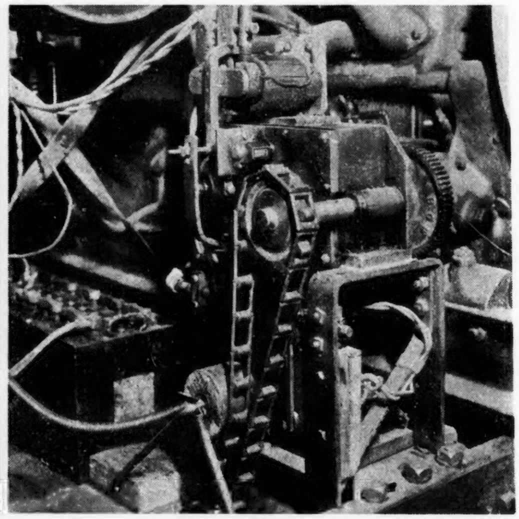


Fig. 11. (Right) The gear box driven from the generator connection of the engine gives the necessary reduction in speed to drive the Gulley recording dynamometer. It is equipped with a magnetic clutch to start and stop the recording mechanism. It also drives an engine revolution counter and a tachometer. The outside set of gears can be changed so as to give one, two or four inches of paper travel for every one thousand revolutions of the engine

Fig. 12. (Left) This shows contactor that operates machine counter attached to end of cutter shaft, also U tube filled with water for measuring static pressure at bottom of blower pipe

vestigation and I would like to see tests made giving the result obtained from differences in the clearance of the fan wings in the housing and also results obtained from fan wings being set radially, or the outer edge of the fan wing being in front or behind a radial line from the center of the disk.

Mr. Ocock: We did a lot of experimenting in the matter of fan wing clearance, but not very much on the angle proposition. We do know that you must have just so much clearance. Our experience has been, if you have too much clearance at the side, you lose the power of elevating. If you have too much clearance at the end you also lose. In our experience, you must have the fan wing running close to all side surfaces of the drum. It is an impossibility to do good work without that. I think, if I understood Prof. Duffee correctly, he referred to the matter of eight fan wings and four knives?

(Continued on page 12.)

Official Report of Silo Filler Tests

Conducted by the Agricultural Engineering Department, College of Agriculture, University of Wisconsin, September 23—October 13, 1924
F. W. Duffee, in charge of tests, C. E. Walsh and T. L. Koontz, assisting

RESULTS

OBSERVE NOTES

No.	No. of Test	CUTTER	Type—Flywheel or Cylinder	Size—inches	Length of Cut—inches	Cutter Speed—r. p. m.	Fan Speed—r. p. m.	Tons per hour	Average Horsepower	Horsepower Hours per ton
1	1	Advance-Rumely	Fly	15	0.520					
2	2	Advance-Rumely	Fly	15	0.520	487		17.03	16.13	0.946
3	3	Advance-Rumely	Fly	15	0.520	593		21.36	24.86	1.164
4	4	Advance-Rumely	Fly	15	0.520					
5	5	Advance-Rumely	Fly	15	0.520	642		26.70	32.39	1.213
6	6	Advance-Rumely	Fly	15	0.520	628		32.40	32.03	0.988
7	7	Advance-Rumely—(Note 8)	Fly	15	0.520	978		20.00	32.25	1.612
8	1	Advance-Rumely	Fly	11	0.496	625	failed to elevate			
9	2	Advance-Rumely	Fly	11	0.496	625	failed to elevate			
10	3	Advance-Rumely	Fly	11	0.496	923		15.95	20.42	1.280
11	4	Advance-Rumely	Fly	11	0.496	983		15.42	22.71	1.473
12	5	Advance-Rumely	Fly	11	0.496	990		15.90	21.95	1.380
13	6	Advance-Rumely	Fly	11	0.496	775	failed to elevate			
14	7	Advance-Rumely	Fly	11	0.496					
15	1	Case	Fly	14	0.460					
16	2	Case	Fly	14	0.460	530		16.45	18.79	1.142
17	3	Case	Fly	14	0.460	604		23.53	24.49	1.040
18	4	Case	Fly	14	0.460	725		25.09	31.58	1.260
19	5	Case	Fly	14	0.460					
20	6	Case	Fly	14	0.460	591		29.85		
21	7	Case	Fly	14	0.460	646		15.72	20.63	1.313
22	1	Gehl—(Note 4)	Fly	15	0.558	475		21.70	16.33	0.752
23	2	Gehl—(Note 4)	Fly	15	0.558	465		19.26	13.26	0.688
24	3	Gehl—(Note 4)	Fly	15	0.558	576		22.10	19.65	0.899
25	4	Gehl—(Note 4)	Fly	15	0.558	662		22.80	25.05	1.098
26	5	Gehl—(Note 4)	Fly	15	0.558	656		25.71	26.66	1.037
27	6	Gehl—(Note 4)	Fly	15	0.558	560		30.06	26.07	0.867
28	7	Gehl	Fly	15	0.558	542		17.15	17.68	1.031
29	1	Gehl—(No. 17)	Cyl.	15½	0.520	501	501	21.30	17.03	0.799
30	2	Gehl—(No. 17)	Cyl.	15½	0.520	513	513	16.40	12.98	0.791
31	3	Gehl—(No. 17)	Cyl.	15½	0.520	605	605	19.69	19.37	0.984
32	4	Gehl—(No. 17)	Cyl.	15½	0.520	750	666	20.73	24.75	1.194
33	5	Gehl—(No. 17)	Cyl.	15½	0.520	753	753	23.17	30.89	1.333
34	6	Gehl—(No. 17)	Cyl.	15½	0.520	634	634	27.30	29.31	1.074
35	7	Gehl—(No. 17)	Cyl.	15½	0.520	590	664	17.27	21.18	1.225
36	1	McCormick-Deering—(Note 5)	Fly	14	0.440	501		18.95	24.97	1.316
37	2	McCormick-Deering—(Note 5)	Fly	14	0.440	508		15.88	21.63	1.362
38	3	McCormick-Deering—(Note 5)	Fly	14	0.440	646		20.68	30.32	1.466
39	4	McCormick-Deering—(Note 5)	Fly	14	0.440	761		19.98	36.90	1.847
40	5	McCormick-Deering—(Note 5)	Fly	14	0.440	704		24.28	40.52	1.670
41	6	McCormick-Deering	Fly	14	0.440	631		28.31	32.73	1.156
42	7	McCormick-Deering	Fly	14	0.440	539		16.68	19.85	1.190
43	1	Rowell	Fly	13	0.454	550		16.70	17.36	1.039
44	2	Rowell	Fly	13	0.454	556		13.45	13.41	0.997
45	3	Rowell	Fly	13	0.454	675		16.08	18.19	1.131
46	4	Rowell	Fly	13	0.454	797		16.00	21.47	1.342
47	5	Rowell	Fly	13	0.454	780		21.40	28.97	1.354
48	6	Rowell	Fly	13	0.454	676		23.12	25.45	1.101
49	7	Rowell—(Note 11)	Fly	13	0.454	609		11.79	(See Note 11)	
50	1	Rowell (16 A)	Cyl.	16	0.590					
51	2	Rowell (16 A)	Cyl.	16	0.590					
52	3	Rowell (16 A)	Cyl.	16	0.590	613	736	22.61	23.50	1.038
53	4	Rowell (16 A)	Cyl.	16	0.590					
54	5	Rowell (16 A)	Cyl.	16	0.590					
55	6	Rowell (16 A)	Cyl.	16	0.590	633	759	27.74	28.38	1.022
56	7	Rowell (16 A)—(Note 7)	Cyl.	16	0.590	566	679	17.70	15.28	0.862
57	1	Smalley (No. 16)—(Note 6)	Cyl.	15	0.490	375	525	failed to elevate		
58	2	Smalley (No. 16)—(Note 6)	Cyl.	15	0.490	375	525	failed to elevate		
59	3	Smalley (No. 16)—(Note 6)	Cyl.	15	0.490	477	668	10.97	13.02	1.187
60	4	Smalley (No. 16)—(Note 6)	Cyl.	15	0.490	568	795	11.15	16.34+	1.465+
61	5	Smalley (No. 16)—(Note 6)	Cyl.	15	0.490	551	784	13.04	20.80	1.595
62	6	Smalley (No. 16)—(Note 6)	Cyl.	15	0.490	473	662	14.55	17.70	1.217
63	7	Smalley (No. 16)	Cyl.	15	0.490		insufficient pipe furnished			

Note 1—Applying to all cutters. The high speeds chosen for these tests are approximately the same as the present average recommended speeds for the particular size Intermediate speeds are 20 percent slower. Low speeds are 40 percent slower.
The speeds for cylinder type machines are selected as above.
The cylinders on four-knife machines were operated 25 percent slower than on three-knife machines in order to give the same number of cuts per minute. Capacities and speeds were made to correspond as closely as possible to the following:

Test No. 3 on each machine was run at intermediate speed and a capacity about 75 percent of maximum for that speed.
Test No. 1 Slow speed, and capacity equal to tests No. 3.
Test No. 2 Slow speed, and 75 percent of maximum for that speed.
Test No. 4 High speed, and capacity equal to test No. 3.
Test No. 5 High speed, and 75 percent of maximum capacity for that speed.
Test No. 6 Maximum capacity at intermediate speed.
Test No. 7 Minimum speed to elevate 75 feet, at a capacity about 75 percent of maximum for that speed. Except on the Advance-Rumely (15 inch) which was operated at a lower capacity in proportion to the speed.

Note 2—For all tests except No. 7 the cutters elevated into silos 35 to 37½ feet high except the Smalley which elevated 30 feet, and both Advance-Rumelys 42 feet.
Note 3—Blank lines indicate the test was not conducted or was incomplete, and was not the fault of the cutter in any way.
Note 4—Only two sections of distributer used. This probably reduced the power required very little if any.
Note 5—Results except tests Nos. 6 and 7 not comparable with other machines as the corn was quite dry and of heavier growth, and a large stream of water was discharged into the fan. This would increase power requirements and reduce the tonnage per hour.
Note 6—Same as Note 5 for all tests.
Note 7—A new model with a smaller pipe was used for this test. There was no evidence of weakness in elevation in the older model.
Note 8—Retest asked for—too late to be given.
Note 9—The corn cut by the Advance-Rumely, Case, Gehl and Rowell machines had a moisture content varying from 70 to 77 percent. The corn for the McCormick-Deering and Smalley tests was considerably dryer and averaged approximately 65 percent water.
Note 10—Uniformity of cut excellent on all except Rumely, which mashed the corn. Knife angle changed by Rumely engineer which overcame trouble. Cylinder cut machines tend to cut more uniformly.
Note 11—Cutter okeh; power recording pencil of engine stuck. The operator failed to entirely unlock the recording mechanism of the dynamometer, and this was not discovered until after all the corn was cut. The cutter operated satisfactorily and apparently the power required was between 1.1 and 1.2 horsepower-hours per ton.

SPECIFICATIONS OF THE MACHINES

NAME OF CUTTER	Type	SIZE—Inches				CUTTER HEAD		FAN			Drive	Blow pipe diameter —inches
		Rated	Actual Throat width	Maximum Throat height	Maximum Throat opening	No. of Knives	Bearings	Bearings	Diameter —inches	No. of blades		
Advance-Rumely	Fly	15	14½	6¾	97.9	3	Ball		48	6		6½
Advance-Rumely	Fly	11	10½	6½	68.2	2	Ball		39	4		6½
Case	Fly	14	13⅛	7⅝	101.7	3	Babbitt		42	6		7
Gehl	Fly	15	14¼	5¾	82.0	3	Babbitt		43	6		7¾
Gehl	Cyl.	15½	14¼	5⅜	76.5	3	Babbitt	Babbitt	38	6	T.P.	7¾
McCormick-Deering	Fly	14	14	6¾	94.5	3	Babbitt		44	6		8¾
Rowell	Fly	13	12⅛	6¼	75.7	3	Hyatt		40	6		6⅜
Rowell	Cyl.	16	14½	4⅛	59.8	3	Babbitt	Babbitt	39	5	R.C.	8
Rowell	Cyl.	16	14½	4⅛	59.8	3	Babbitt	Babbitt	39	5	R.C.	7
Smalley	Cyl.	15	13½	3⅝	48.9	4	Babbitt	Babbitt	38	4	R.C.	8

Note 1—Maximum throat opening is given in square inches.
Note 2—T. P.—Triple pulley.
Note 3—R. C.—Roller chain.

(Continued from page 11.)

Mr. Duffee: Yes.

Mr. Ocock: I want to cite our experience along that line. The matter came up concerning the diameter of the flywheel and the length of the knives, also the number of fans and the number of knives. A 16-inch machine was built with eight fan blades and four knives. In a test with the machine we used an 8-16 horsepower engine and 65 feet of pipe with two men on the load. The machine would take the corn stalks as fast as they could feed, and it did not seem to bother the engine in the least. They could throw the corn in just as fast as they pleased, and the silo filler put the silage out at 65 feet just as easy as though you were blowing paper off the table. The man in charge, or the man who had the authority to say so, decided that eight fan wings were too many, and that it took too much power. I argued with him considerably about the matter, but the orders were to take off four of the fans, and they were taken off. By the way, we are operating that machine at 550 r. p. m. The result was, after we took the four fans off, that the 8-16 horsepower engine would not pull the load. It took a 12-25 engine, and then the engine had all it could do at 750 to 800 revolutions to throw the silage out of a 65 foot pipe.

Prof. Duffee: Possibly with three knives it would reduce the power still more.

Mr. Kranich: About three or four years ago the Committee on Belt Power Machinery of this Society tried to work out a formula, and did present one, using a constant. I would like to ask Prof. Duffee whether that was any where near the constant he found now.

Prof. Duffee: That was in 1921. The factor was 0.00016 I believe. When it came to feeding cutters up to capacity that year, it was a joke absolutely. We didn't reach capacity last year, as Mr. Aspenwall, Mr. Merwin and others know, except occssionally on smaller machines. The factor was 0.00016; the factor we get now is 0.00036, more than twice as much.

Prof. McCuen: I regret we were unable to go ahead with our anticipated tests on ensilage cutters at Ohio State University this fall.

One factor I am glad Prof. Duffee brought out was the human element, which we found to be a large factor in putting up ensilage. A large number of cutters are too large for the size of the crew which will use them efficiently. I believe, as we have studied the situation in Ohio, that the size of the cutter will be dependent on the power available which will operate the cutter efficiently.

I had an interesting question asked me the other day. A farmer had had trouble driving his ensilage cutter with the power he had. I do not recall the name of the cutter, but I do recall that it was a 13-inch machine, and his power was a Fordson tractor. It was a question of proper speed, the cutter was being driven too fast—about 250 r. p. m. above its rated speed. I cited to him the work that Prof. Duffee had done last year and made recommendations that he purchase a pulley for the cutter that would reduce its speed down to about 500 r. p. m. I am sure if he will use the combination recommended that very little trouble would be had next year. We hope to obtain some interesting data as a matter of comparison of the two years of ensilage cutting from this farmer.

Mr. Duffee: We recommend farmers to use the slowest speed that will safely elevate their corn. We would like to recommend definite slower speeds, but as Prof. McCuen knows and as we know, it is dangerous to recommend too slow a speed as many of the machines the farmers have at the present time have to be run 700 to 900 r. p. m. in order to elevate. We are very anxious for the manufacturers to check their machines, and if there are any elevating deficiencies, that they correct them, so as to be able to profit by the economy of slower speeds.

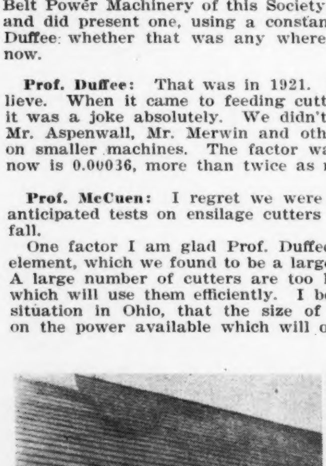
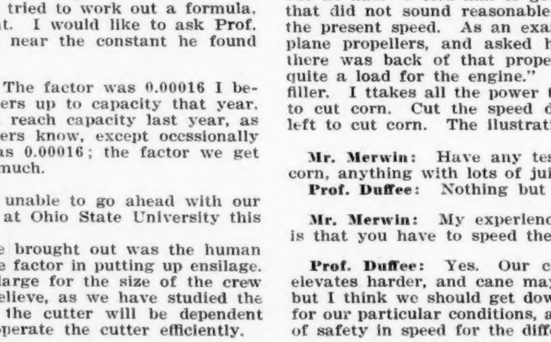
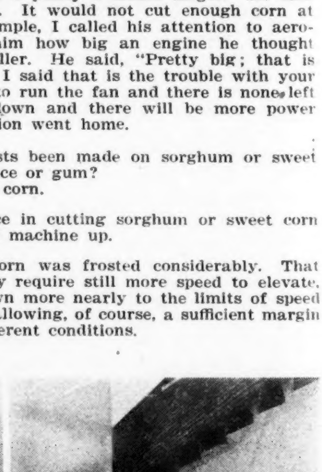
I had a farmer in to see me last summer about the same thing Prof. McCuen speaks of. He has a 14-inch International cutter, and he wanted to trade it off for a 16-inch, because his engine couldn't pull it. That is the first time I ever heard of a man wanting to get a larger size when the engine couldn't pull the one he had. I told him to get a pulley 4 inches larger. He said that did not sound reasonable. It would not cut enough corn at the present speed. As an example, I called his attention to aeroplane propellers, and asked him how big an engine he thought there was back of that propeller. He said, "Pretty big; that is quite a load for the engine." I said that is the trouble with your filler. I ttakes all the power to run the fan and there is none left to cut corn. Cut the speed down and there will be more power left to cut corn. The illustration went home.

Mr. Merwin: Have any tests been made on sorghum or sweet corn, anything with lots of juice or gum?

Prof. Duffee: Nothing but corn.

Mr. Merwin: My experience in cutting sorghum or sweet corn is that you have to speed the machine up.

Prof. Duffee: Yes. Our corn was frosted considerably. That elevates harder, and cane may require still more speed to elevate, but I think we should get down more nearly to the limits of speed for our particular conditions, allowing, of course, a sufficient margin of safety in speed for the different conditions.

This is an ideal barn for young stock; it is of permanent construction, well ventilated, and yet warm. It will be noted that neither intake or outtake flues occupy any space inside the barn to interfere with pen or stall construction

Cutting Corn in the Field or at the Silo*

By J. D. Parsons

Mem. A. S. A. E. Assistant Professor of Agricultural Engineering, University of Nebraska

THE handling of corn in early times was always hard, disagreeable work. Planting the seed with a hoe, cultivating the young corn with the hoe, and cutting the mature corn with the knife and shocking it for storage; all of these operations were back-breaking, monotonous jobs. After many centuries the planter, crude as it was at first, relieved man of the stooping and backache of the planting operation. Later came the cultivator that allowed man to utilize animal power to tend and cultivate his corn. Comparatively recently has come the corn cutter or corn binder that relieved man of the tiresome operation of stooping and cutting off each stalk of corn. With the advent of the corn binder, permitting the handling of corn in bundles, the silo and the ensilage cutter came into prominence.

The planter has taken practically all of the hard manual labor out of planting the seed, and the cultivator has accomplished the same results for tending the crop. But the binder and ensilage cutter require the hard, distasteful job of handling heavy bundles of green corn. It is true that mechanical loaders have been used to take the bundles from the binder and elevate them on to a wagon, but even then it is necessary for the bundles to be handled from the loader into position on the load, and from the load to the ensilage cutter. The mechanical loaders have not proved an entire success in loading the bundles from binder to wagon, and even if they had there is still the second handling of the bundles at the ensilage cutter.

The tendency at the present time, in Nebraska at least, is toward a decrease in the use of the silo. This condition is a result of several things. (1) The scarcity and unreliability of farm labor resulting in the using of fewer regular farm hands; (2) As a partial result of the first, the need of cooperating with neighbors in the silo-filling operation; (3) Since silo-filling is hard, disagreeable work when the corn is cut at the silo; it is hard to trade work of other farm operations for silo-filling work; and (4) filling the silo with large crews that make a business of silo-filling is expensive and the usual difficulty is encountered in obtaining a crew at just the right time.

The alternate method of cutting ensilage in the field is relatively new and in some parts of the country has not yet been tried out. In this second method the corn is cut into ensilage by a cutter which is attached to or is part of the mechanism for cutting and elevating the stalks of corn. This cutting and elevating mechanism is similar to the same part of the ordinary corn binder. After the corn is cut, elevated, and cut into ensilage it is elevated into a wagon driven alongside the machine to receive it. This mechanism is all driven from a power-take-off from the tractor on which it is built. The loaded wagons are then taken to the silo where they are dumped into a pneumatic elevator and the ensilage elevated into the silo without any hard disagreeable labor.

This makes it possible for boys and older men to make full-fledged hands in this kind of a crew, because outside of the man on the cutter and the man at the silo about the hardest work is driving a team. Some objection has been raised to this method on account of the extra equipment required. For this system a small tractor is required in the field upon which the harvester is built. Then at the silo there is a pneumatic elevator and a stationary engine or a tractor to drive the elevator. This elevator lets the front end of the wagon down and allows the ensilage to be taken out of the wagon into the elevator. In addition to this there is sometimes added a lift for the front end of the wagon. This can be eliminated by digging down for the rear wheels and grading up a little for the front wheels. (This arrangement is really more convenient than the lift although it requires a team to move the wagon away from the elevator.)

It will be seen that, if a tractor were used on the corn binder, each method would require about the same amount of equipment. If, however, the corn binder was drawn by horses there would be an engine extra in the cutting in the field or second method. To offset this it might be stated that the elevator used in the second method may be used as an elevator for all kinds of grain except ear corn, so that this part of the equipment would be useful at times other than at silo filling.

The cost of equipment not counting the tractors or engines, would be in favor of the method of cutting ensilage at the silo. The equipment for cutting ensilage in the field, not counting tractors would be about $750, while the cost of a binder and ensilage cutter would amount to $550. This shows a difference in price of about $200 in favor of cutting ensilage at the silo.

Pit silos are being used to some extent in some parts of the country, and where the pit silo is used it is not necessary to provide an elevator at the silo in the second or field method of cutting ensilage. In this case the wagon is backed to the edge of the silo, the front wheels elevated and the load pitched out, or, as it is often done, a piece of wire fencing is laid on the bottom of the wagon and temporarily secured to the back end of the wagon by a block and the other end of the fencing carried up over the front of the wagon box. The load of ensilage is put right in on top of the wire and the load backed up to the pit silo. The team on the wagon is taken off the wagon, taken to the opposite side of the silo and attached by a rope to the front end of the fencing in the bottom of the wagon; the team then peels the load out of the wagon into the silo. A separate snatch team may be kept at the silo for this purpose if desired. Since the use of the pit silo eliminates the need for an elevator and engine at the silo, it brings the cost of the equipment for the field method of cutting ensilage below the cost of equipment for the silo method.

The man power necessary to operate by the two methods would be in favor of the field method as the two to six men required for loading bundles would not be needed in the field method. It is claimed that the field method would require fewer teams on account of being able to haul bigger loads; the size of the load in the silo method, it is claimed would be limited by the height to which the loader could conveniently pile the bundles. This would not hold, however, in the case of the mechanical loader. As I see it the number of teams would be about the same by either method for any given number of ton miles of silage.

To me the chief advantage of the field method lies in the fact that it takes the hard manual labor out of the silo-filling job and enables the farmer to fill his silo in some cases with only his own crew. A more or less serious drawback to the field method of cutting ensilage is the fact that in case of breakage of any part of the cutter it would not be probable that a replacement could be borrowed from a neighbor, while in the case of damage to a binder or even to an ensilage cutter it is probable that a replacement could be borrowed from a neighbor.

The machines on the market today for filling the silo by the field method are not entirely satisfactory; the defects are mechanical and can and doubtless will be quickly overcome. The general plan seems very good and a large percentage of the users of the field method of cutting ensilage say they would be very reluctant to return to the silo-cutter method of filling the silo.

*Paper presented at the eighteenth annual meeting of the American Society of Agricultural Engineers, Lincoln, Nebraska, June, 1924.

Research in Agricultural Engineering

Research activities in the agricultural-engineering field are presented under this heading by the A. S. A. E. Research Committee. Members of the Society are invited to discuss material presented, to offer suggestions for timely topics, and to prepare special articles on any phase of agricultural engineering research

Evolution and Progress of Agricultural Engineering at the Agricultural Experiment Stations*

By R. W. Trullinger

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(Continued from December Issue)

Drainage and Irrigation

Other branches of agricultural engineering which merit the same consideration are drainage and irrigation. Numerous unsolved and very pressing problems are offered by each of these branches, and many of them appear to be susceptible of treatment and solution by the same general methods of attack applicable to problems in farm machinery and structures.

Drainage. Drainage, for instance, is a subject upon which a large amount of work, mostly of a service nature, has been done. With the exception of the studies at the Missouri station on water absorption, run-off, percolation, evaporation, capillary water movement, and erosion under field conditions (48),** there is practically no record of fundamental studies on this subject by the experiment stations. A consideration of the soil, beyond rather vague empirical treatment, has seldom been undertaken in this country as a basic consideration and logical starting point in drainage studies. Certain foreign agricultural experiment stations, however, have taken the view that the soil and the crop to be grown are the things most vitally concerned in drainage, and have based their investigations on this conception.

A step in this direction was taken recently in studies of underdrainage at the North Carolina station, in cooperation with the United States Department of Agriculture, by H. M. Lynde (49). The result indicated that the texture of the soil is the controlling factor in the efficiency of underdrainage, and that in nonhomogenous soils the spacing and depth of drains should be such as to suit average soil conditions as nearly as possible, and emphasized the importance of studying the influence of the physical and chemical properties of the soil and of different soil treatments and crops on underground run-off.

Investigation on the drainage of irrigated lands has recently been given considerable impetus by several of the experimnt stations in the arid and semiarid states. W. W. Weir, in discussing the work by the California staton (50), has summarzed the situation, bringing out particularly the importance of the soil itself as the thing most vitally affected and the factor of primary importance from the standpoint of investigations.

Irrigation. Irrigation is an agricultural engineering subject which has received much attention at the experiment stations. Practicaly every experiment station in the irrigated states has had projects in irrigation at one time or another, and there is a record of at least forty active subjects in twelve states. Some of these are obviously too indefinite or general to lay claim to a research status. Many, however, are planned along research lines. The studies have covered almost all phases of irrigation; but it seems that the fundamental factor, the soil, has received relatively little study in its relation to irrigation.

With this factor in view, O. W. Israelsen and F. L. West have conducted studies at the Utah station on the capacity of soils in the natural field condition to absorb and retain irrigation water (51). The significant conclusion was drawn that, as a general rule, soils have the capacity to absorb from 0.5 to 1.5 inches of water to each foot of depth of soil that needs moistening, and that the actual capacity of a given soil depends upon its texture and structure. Sandy or gravelly soils naturally retain the smaller amounts and clay loam soils the larger amounts.

Moisture studies of 670 soil samples at the Washington station by R. P. Bean (52), conducted principally in connection with border irrigation experiments, showed that, generally speaking, most of the moisture was held in the first 4 feet. Only under exceptionally heavy irrigation did the samples show any pronounced increase of moisture in the fifth and sixth foot. Lateral distribution of the moisture was very uniform, and under experimental conditions 24 hours was sufficient for the irrigation moisture to reach the soil mixture vertically and the soil moisture 36 inches away horizontally.

Studies by Israelsen and L. M. Winsor at the Utah station (53), on the net duty of water for staple crops on gravelly sandy loam and fine sandy loam soils, were begun by a consideration of the average permeability of the soils and their maximum capacities for absorbing and retaining water. On this basis the experiments were extended to show the proper use of water on such crops as beets, potatoes, and alfalfa.

The extensive work at the California station on different phases of soil moisture and its movement in relation to irrigation furnishes perhaps the most comprehensive view of the significance of the soil and its hydraulic characteristics as a prime factor in irrigation studies (54, 55). These have brought out especially the significance of such factors as capillarity, evaporation tendencies, organic matter content, and cultivation.

These and numerous other studies indicate that not enough is yet known regarding the hydraulic properties of soil to furnish a sufficiently substantial basis for drainage and irrigation studies. A review of the soils projects at the different experiment stations indicates that there are in operation at least nineteen projects at as many stations on the relation of soil moisture and soil moisture movement to the physical and chemical properties of soils. The purely agricultural subject of soils and the engineering subjects of drainage and irrigation are obviously closely related in many respects. It would seem, therefore, that cases might frequently occur in which cooperation between the soils and agricultural engineering departments would be profitable in establishing fundamental hydraulic principles governing the movement and activities of water in soils as bases for drainage and irrigation studies.

Farm-Sewage Disposal

Numerous attempts have been made from time to time at several of the experiment stations to meet the pressing

*Reprint from the Report of the Work and Expenditure of the Agricultural Experiment Stations, 1922, published by the U. S. Department of Agriculture.

**The numbers in parentheses refer to references that follow this report.

demand for so-called practical information on the subject of farm-sewage disposal. A review of the attempts shows them to be generally lacking in the elements of advanced research. The importance of a consideration of the subject from its logical beginning through its scientific contacts to an ultimately practical solution for definite groups and clesses of conditions has, however, been emphasized in some of these projects.

The Illinois station has undertaken a cooperative project designed to bring out some of the relations between sewage-tank dimensions and the chemical and biological changes taking place therein. The New Jersey stations have made an important preliminary contribution to the subject in the study by J. W. Thomson of the biology of sewage filters (56), and H. E. Murdock at the Montana station has engaged in a study of the factors governing the operation of both septic and Imhoff tanks (57). The Kansas State Agricultural College has a project on the subject which is also well worthy of attention in that it proposes to develop a fundamental study lasting from 5 to 10 years. In this connection, preliminary studies by H. B. Walker (58) on flow characteristics of household sewage from the isolated home have shown that the flow assumptions sometimes made for the design of sewage ranging from 30 to 75 gallons per person per day are too high.

A careful consideration of all the factors involved in the subject of farm-sewage disposal, with particular reference to the object to be accomplished by sewage-disposal measures, indicates the importance of first studying, analyzing, and classifying the conditions to be met by such measures. This was done in a tentative way by R. W. Trullinger, of the Office of Experiment Stations (59), but in a manner sufficiently comprehensive to show the possibilities of such a procedure. The work of H. W. Riley at the New York Cornell station (60,61), of J. H. Haswell at the Pennsylvania station (62), and of several of the state departments of health has shown that such procedure is well worthy of consideration as a preliminary to undertaking studies on farm-sewake disposal.

Materials of Construction

Construction material is a subject which has developed from a minor miscellaneous matter into one of the most important branches of agricultural engineering; and its rise to such a position can be considered as a natural result of the development of agricultural engineering as a whole, owing probably to the fact that it bears a close relation to all other branches of the subject.

A great deal of the work done at the experiment stations on materials of construction has been of a very general and apparently comparitive or elementary nature. Some of it, however, has had very definite objectives. Thus studies on the preservative treatment of posts and timbers used in farm structures have a very evident object in view which frequently takes many years to attain. The work at the Iowa station (63, 64), for instance, on the preservative treatment of farm timbers, which has been carried on for 16 years, has shown that the quick-growing nondurable Iowa woods can be successfully used for fence-post purposes after having been properly treated with creosote, and that durable fence-post woods, such as white cedar, can be made to last for a long period of years with little deterioration after creosote treatment.

Results of a similar nature have been obtained by J. C. Wooley at the Missouri station (65) and by A. K. Chittenden at the Michigan station (66). In addition, a nine-year study at the Iowa station of over 700 concrete fence posts of different types has indicated that four 0.25-inch square twisted reinforcement rods are necessary to develop maximum strength without the excessive use of steeel (67). An eleven year study of roofing materials at the Iowa station (67, 68) has indicated the lower durability of materials with a high volatile content, and that a protective layer of mica, sand, or crushed stone has a beneficial influence upon durability. A thirteen year study of shingles at the Pennsylvania station has also yielded valuable data on shingle preservation (69).

In studies at the Minnesota station on the effect of organic decomposition products in soils of high vegetable content upon concrete draintile (70), Elliott showed that concrete tile always contain free alkali. This reacts with acid organic compounds from peat soils, producing gelatinous compounds which are soluble in water containing carbon dioxid, Therefore, concrete tile as at present made are likely to fail as drainage structures when used in peat soils in the presence of water.

Closely related to this work are the studies conducted by K. Steik at the Wyoming station on the effect of alkali upon Portland cement (71, 72). The results of these showed that the chief reacting substance in Portland cement is lime in the form of calcium hydoxid. Cement set as well in solutions of alkali salts as in water, and magnesium chlorid had the greatest disintegrating effect. Sodium sulphate was more harmful than magnesium sulphate, and the presence of sodium chlorid in solutions of either increased their harmful effect upon cement, while the presence of sodium carbonate retarded it. The tensile strength of cement was the factor most affected by alkali solutions, decreasing most rapidly in all solutions, even when the compressive strength was increased. Waterproofing paints offered only temporary protection against alkali solutions. Obviously this work might be carried much further in the development of resisting processes.

The transmission of heat through wall materials is a matter of vital importance in farm-building design. In this connection G. A. Cumings, of the Colorado station, studied the factors governing the transmission of heat through commercial wall board (73), and found that the average coefficient of heat transmission varied from 0.73 B. t. u. per hour per square foot per degree Fahrenheit difference in temperature from Beaver board to 1.01 for sheet rock wall board. These materials were found to be slightly inferior to common lath and plaster 0.5 inch thick and superior to wood in many cases of light construction.

These studies indicate lines and starting points for further study of the respective problems, and bring out the importance of securing effective cooperation in such studies, particularly where needed in the more technical phases of the work.

Land Clearing

Work on land clearing at the stations has developed rapidly during recent years; but it is still quite indefinite in nature, and it is difficult in many cases to see wherein the principles of research might be applied in the solution of specific problems.

There are at least thirteen distinct projects in land clearing at six different stations, most of which deal with comparisons of known or available methods and apparatus for land clearing and the cost thereof. The projects at the Wisconsin stations are among the more comprehensive in that they not only deal with stump and brush removal by explosives and machinery, but have involved the development of new types of plows and cultivating machinery adapted specifically to the breaking and cutlivation of the cleared land.

For example, experiments by J. Swenehart and F. W. Duffee, of the Wisconsin station (74) on an improved brush-breaking plow indicated the necessity of redesigning and offsetting the beam to prevent the accumulation of roots and brush. Studies by Swenehart (75) on T.N.T. as a land-clearing explosive showed that this material is relatively very insensitive and difficult to detonate as a blasting explosive. Experiments by Swenehart on the use of picric acid as an agricultural explosive (76) resulted in the recommmedation of the use of this material in open-air blasting work, provided its cost is less than that of other commercial explosives.

Work on engineering equipment for land clearing by Swenehart (77) resulted in mechanical methods and apparatus for removing and handling stumps, the development of which obviously involved an extensive consideration of fundamental physics and mechanics.

Studies by O. I. Bergh and A. H. Benton, of the Minnesota station, on the comparative values of different methods of land clearing (78) showed conclusively the advantage of

pulling over dynamiting in stump removal, although shattering before pulling had a slight advantage over pulling alone. Forty per cent dynamite gave better results than 20 per cent as an explosive.

Studies by M. J. Thompson, of the Minnesota station, on forced versus delayed systems of clearing stump land (79) indicated the superiority of the delayed system.

Experiments by W. Rudolfs, of the New Jersey stations (80), demonstrated that sulphur is valueless for killing live stumps, but that rock salt when applied in proper amounts is quite effective.

H. D. Scudder, of the Oregon station (81), devised a new method of removing stumps by burning, which involves the use of a furnace, hood draft pipe, and chimney. By means of these a hole is burned through the base of the stump, converting it into a stove, which eventually destroys itself. This method is especially adapted for the removal of the larger stumps.

The work of Nichols and E. G. Easter, of the Alabama station, has involved considerable work on the clearing of cut-over lands by blasting and other methods (82, 83). Apparently blasting is the favored method. In this connection it has been realized by these investigators that not enough is yet know of the factors which govern stump removal by explosives. The conditions of existence of stumps are apparently too variable to permit of an exact application of the principles of ballistics in determining explosive forces necessary for breaking taproots, lifting and inverting the stump, and breaking the lateral roots. However, an attempt has been made to arrive at this information in an indirect manner (84), and some fundamental factors have already been established relating to location, depth, and angle of bore hole, type, size, and manner of placing of charge, and other factors which influences the necessary explosive force. The purpose has been obviously to establish some of the requirements which explosives must meet in stump removal to serve somewhat as a guide to explosive manufacturers. This constitutes a distinct departure from the usual comparative testing method and seems to indicate wherein research methods may be applied in some features of the land-clearing problem.

Soil Erosion

Soil erosin and methods for its prevention offer considerable opportunity for fundamental study, particularly in the South Atlantic and Gulf Coast states. Much of the work hitherto undertaken on this subject at the stations has consisted mainly of comparative tests of terraces of different shapes, sizes, and grades. It is believed that this work should start with a consideration of the factors governing the erosion of soil by water, the influence of different treatments on these factors, and the amount of soil removed by running water under known conditions. Studies could then be intelligently undertaken to develop methods of prevention of erosion.

It is realized that, when dealing with so variable a factor as soil, it is difficult to apply intelligently any established method of research procedure in the solution of the erosion problem. However, a beginning has been made by M. F. Miller, F. L. Duley, and O. B. Price, at the Missouri station (58,86), in studies on water absorption, run-off, percolation, evaporation, and capillary water movement in relation to soil erosion under field conditions. These have already brought out some rather general relations between erosion and types of tillage and nature of vegetation, and have indicated the rapid erosive tendencies of scraped soils and the superiority of a crop-rotation system over continuous grain cropping in this respect. It is believed that elaborations or modifications of this method of work to meet the specific soil, climatic, and farming conditions of other states might aid materially in placing the development of methods of soil erosion upon a more stable basis.

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The picture shows good examples of applied agricultural engineering. Note especially the shed for the manure spreader.

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in rural engineering, Office of Experiment Stations, U. S. Department of Agriculture

Friction Tests of Concrete on Various Subbases, A. T. Goldbeck. (U. S. Department Agriculture, Public Roads, Washington, D. C., 5 (1924), No. 5, pp. 19, 20, 23, figs. 1.) Studies on the force of friction at the base of concrete roads are reported. Slabs 2 feet wide, 6 feet long, and 6 inches thick of 1:1.5:3 concrete were cast on 12 subbases, consisting of (1) clay with smooth top surface, (2) clay with cobblestones partly rolled in the surface, (3) broken stone, 0.75 inch to dust, flat top surface, (4) concrete base with top surface troweled smooth, (5) loam with smooth top surface, (6) sand with top surface smoothed and oiled with heavy flux oil, (7) clay with surface scored to make it uneven, (8) gravel, 0.75 to 0.25 inches, flat surface, (9) broken stone, three inches, (10) concrete base, troweled surface, oiled with heavy flux oil, (11) sand with smooth surface, and (12) clay oiled with heavy flux oil. Each specimen weighed approximately 870 pounds.

The results showed that movement took place almost as soon as the load was applied in all cases except that in which large broken stone was used in the base. In this case there was great friction from the start until a load of 1,000 pounds was reached, when slipping occurred. Great force was required to start the slab, after which no more was necessary than in some of the other bases. Apparently the coefficient of friction is not constant but varies with the displacement. When the slab on the loam base had been slid 0.035 inches, the load was gradually released and the return movement noted. The subbase seemed to behave in a somewhat elastic manner, as the slab actually recovered considerable of its forward movement. Further results showed that much depends upon the moisture condition of the subbase, a wet subbase permitting the concrete to slide much more easily than a dry subbase.

Tests of the effectiveness of a heavy oil coating for decreasing the friction at the subbase showed that heavy flux oil was not effective in decreasing the friction in any of the bases even when applied to the concrete base that had been carefully troweled smooth. The results showed in general that the coefficient of friction can readily vary from almost zero to something over 2.0, depending upon the movement of the concrete and the character of the subbase.

Laboratory Strength-Tests of Motor Truck Wheels, T. W. Greene. (Journal of Society of Automotive Engineers, New York, 15 (1924), No. 2, pp. 150-155, 174, figs. 13.) Laboratory tests conducted at the U. S. Bureau of Standards with two each of standard wood, cast steel, I-beam type, steel disk, aluminum, and rubber cushion motor truck wheels are reported.

A comparison of the important mechanical properties of the six different types of wheel showed that in radial compression all of the wheels are sufficiently strong to withstand any load to which they might be subjected in service, and it is improbable that any of these wheels would ever be stressed even to its proportional limit.

With reference to the secific strength and resiliency deveload in both the radial compression and side thrust tests, the results indicated that the wood wheel is probably the best adapted for motor truck service. Although the other wheels developed considerably higher ultimate strengths, particularly the cast steel and the special steel disk wheel, the proportional limit of the wood wheel was only about 20 per cent less than that of any of the other wheels. The specific strength was higher for the wood wheel than for the others except the aluminum wheel. This was also true of the elastic resiliency and the elastic resiliency per pound of weight.

The I-beam type of wheel was the strongest and most resilient metal wheel tested. Except for resiliency, it compared very favorably with the wood wheel and had the highest proportional limit. Its specific strength was higher than that of any other except the aluminum wheel, and it was the strongest and most resilient in its resistance to side thrust. The aluminum wheel was the lightest one tested, being about 30 per cent lighter than the wood wheel. Its proportional limit in radial compression was about the same as that of any of the other wheels, but its specific strength was the highest. However, this wheel had a very low elastic resiliency and low strength in side thrust.

The cast steel wheel had a high ultimate strength, but the ratio of proportional limit to weight was 17 per cent less than that for the wood wheel. This wheel had a low elastic resiliency value, but it was one of the strongest in side thrust. The steel disk wheel also had a high ultimate strength but a low specific strength and low elastic resiliency. It was very weak in side thrust.

The rubber cushion wheel was one of the strongest tested and was the most resilient. Because of its excessive weight, its specific strength was far below that of the other wheels, but the value of its elastic resiliency per pound was far in excess of that of the metal wheels.

Semi-circular Weirs Calibrated at Purdue University, F. W. Greve. (Engineering News-Record, New York, 93 (1924), No. 5, pp. 182, 183, figs. 2.) The results of tests of semi-circular weirs of six different sizes of openings are presented and discussed, and the equation representing the flow from such a weir opening is deduced.

The Relation Between Durability and Chemical Composition in Wood, L. F. Hawley, L. C. Fleck and C. A. Richards. (Industrial and Engineering Chemistry, Washington, D. C., 16 (1924), No. 7, pp. 699, 700.) In a contribution from the Forest Service and Bureau of Plant Industry, U. S. D. A., studies of the apparent relationship between the chemical composition and durability of woods, as indicated by the toxicity of the extracts made from several durable woods, are reported. Fomes annosus was used throughout as the indicator for toxicity tests.

The results showed that the hot water extracts are all more toxic than the cold water extracts of the same materials. In all cases the sapwood extract was less toxic than the corresponding heartwood extract. It is concluded that the relative resistance to decay of the several woods examined can be largely explained by the toxicity of their extracts. The hot water extracts of the heartwood of the less durable woods, such as red oak and red alder, retard the growth of the fungus less than any of the similar extracts of the more durable species. The cold water heartwood extracts of these species were less toxic than any of the others except yew and white oak, the toxicity of which was practically the same as that of the red oak.

It is concluded that the figures obtained on the relative toxicity of the extracts to F. annosus are in close accord with what is known of the relative durability of the species and forms of wood studied.

California Air-Cleaner Tests, 1924 Series, A. H. Hoffman. (Journal of the Society of Automotive Engineers, New York, 15 (1924), No. 2, pp. 140-148, figs. 8.) In a contribution from the California Experiment Station the results of a continuation of the tests of tractor engine air cleaners begun in 1922 (Agr. Eng., Vol. 4, Nos. 6, 7), are reported.

In the 1924 work road tests of air cleaners were conducted, efforts being made to find out how much dust an engine would draw in if the cleaner and connections were removed, and to catch and weigh the dust the air cleaner being tested failed to catch. The absolute air cleaner used in connection with the air cleaners being tested is described, and standard dusts for testing purposes, including fuller's earth, are discussed. Road tests are treated generally and specifically and compared with laboratory tests, and the 32 air cleaners submitted for testing are described. Tabular data of the test results are included.

It was found that by lotting a curve between the amounts of dust caught on the several cloths of the absolute cleaner and the number of cloths, it was possible to determine the additional amount that would have been caught if a definite number of cloths were used. It was thus possible to determine the composition of the absolute cleaner. It was found that every air cleaner built can be made to test 100 per cent efficient if a shrewd choice is made of the dust to be fed into it. The particles must be large enough so that they can not pass the filter and must be heavy enough so that inertia or gravity will leave them behind when the air going toward the carburetor swings around the turn.

Studies on the Biology of Sewage Disposal, M. Hotchkiss. (Journal of Bacteriology, Baltimore, 9 (1924), No. 5, pp. 437-461, figs. 7.) Two contributions from the New Jersey Experiment Stations and the New Jersey State Department of Health are presented.

1. **A survey of the bacteriological flora of a sewage treatment plant.** By the use of the dilution method employing different media, the bacterial population in a sewage disposal plant was divided into arbitrary groups according to the physiological activities produced. These were organisms (1) reducing nitrate to nitrogen gas, (2) splitting protein with the production of hydrogen sulphid, (3) liquefying coagulated egg albumin, (4) reducing inorganic sulphates to hydrogen sulphid, (5) oxidizing ammonium salts to nitrites, (6) oxidizing nitrites to nitrates, and (7) oxidizing thiosulphite to sul-

phate. No attempt was made to isolate and observe individual bacterial types.

The largest number of bacteria per cubic centimeter were found in the digestive chamber of the Imhoff tank. This was true whether organisms of a reducing or of an oxidizing type were considered. The effluent from the sprinkling filter, except at the time of slough, contained the fewest bacteria per cubic centimeter.

Of the groups considered, the organisms most important numerically throughout the plant were the nitrate reducers, the hydrogen sulphid producers, and the albumin digesters. Nitrifying and sulphur oxidizing bacteria occurred throughout the plant and were consistently found even in the digestion chamber of the Imhoff tank. The material from the digestion chamber, however, contained no nitrites or nitrates. The number of nitrifying organisms increased in the filter bed, although they never became numerically predominant, and higher percentages of nitrifiers were found in liquid which had trickled through the lower levels of the bed than in that collected near the surface.

There was a drop in the numbers of hydrogen sulphid producing organisms as the sewage passed through the plant. This was the most striking change in the bacterial flora which could be demonstrated. It is stated that in general in a sewage plant handling stale sewage in a quantity at about its capacity, the proteolytic and reducing organisms overbalance the oxidizing organisms. However, the results are taken to indicate that by careful operation of a plant a satisfactory effluent can nevertheless be obtained.

2. **A sprinkling filter bed and its bacteriological population.** These studies showed that the film about the stones of a sprinkling filter bed contains bacteria able to accomplish the same physiological activities as those which occur in an Imhoff tank. The stones are seeded by the effluent from the Imhoff tank which is sprayed over their surface. Conditions in the bed affect the types of bacteria with the result that the proteolytic bacteria decrease as the stones of the lower level of the bed are reached, while the oxidizing bacteria increase. This increase in oxidizing bacteria confirms the chemical analysis which show a higher nitrate production in the lowest level of the filter bed. Since many bacteria are able to effect denitrification, these types of bacteria may also be demonstrated readily in the sprinkling filter film.

Saving Gasoline and Increasing Mileage by Proper Carburetor Adjustment, G. W. Jones and A. A. Straub. (U. S. Department Interior Bureau of Mines, Washington, D. C., Serial 2616 (1924), pp. 9, pl. 1.) Studies conducted by the U. S. Bureau of Mines on high test and low test gasolines and a benzol-gasoline blend in order to determine the effect on carburetor adjustment of different fuels are reported.

The results indicated that the average motor vehicle wastes approximately 30 per cent of the heat value of the fuel used, as incomplete combustion products. These unnecessary large heat losses are mainly due to improper carburetor adjustment. It was found that if an automobile, motor truck, or tractor gives good operation without supplying preheated air to the carburetor when a given type of fuel is used, the preheater should not be used. The use of preheated air was found to enrich the carburetor adjustment, especially at high speeds and throttle openings, and at the same time to reduce the mileage which can be obtained per gallon.

It is concluded that the preheater should be used only when necessary, that is, with gasolines which will not give satisfactory operation without preheated air, during cold weather, and before the engine is thoroughly warmed. In the tests an economical adjustment was obtained with a low test gasoline without using preheated air, which gave maximum power when tested on hills at low speeds. When the preheater was used with this adjustment the mileage was reduced, and no measurable increase of power was obtained.

Changing from a low test gasoline to a high test gasoline without changing the carburetor setting, enriched the carburetor mixture and caused less mileage. This is taken to indicate that if such a change is made the carburetor should be adjusted for a correspondingly leaner mixture. On the other hand, if the change is made from a high test to a low test gasoline, the carburetor setting must be changed to a richer adjustment.

The use of motor benzol with a carburetor adjusted for gasoline resulted in a slightly richer mixture and a slightly increased mileage. When the carburetor was adjusted to a leaner mixture, a 50-50 benzol gasoline blend gave an increased mileage of 15 per cent.

Heat Loss Through Wall Constructions, A. Kolflaath. (Journal of the American Society of Heating and Ventilating Engineers, New York, 30 (1924), Nos. 9, pp. 627-643, figs. 7; 10, pp. 661-668, figs. 1). Exeperiments conducted at the Norway Institute of Technology on the principles governing the loss of heat through the walls of 27 different test houses built in an open field are reported. The houses had inside dimensions of 6.6 by 6.6 by 7.5 feet. The data obtained are analyzed primarily for the purpose of indicating their application in the determination of heat transmission coefficients of different types of wall construction.

Standardization of Wheel Track Widths and of the Gather of Axle Skeins and Dishing of Wheels for Farm Hauling, Konschak. (Technikinder Landwirtschoft, Berlin, 4 (1923), No. 7, pp. 109-112, figs. 5.) An analytical discussion of the factors entering into the design of farm wagon wheels, skeins, and track widths, with particular reference to the gather of skeins and the dishing of wheels for different loads and wheel diameters is presented. It is considered desirable for front and rear wheels to have the same track width to bring tractive resistance to a minimum, and a standard track width of 1,520 millimeters (59.84 inches), between centers of felloes is also considered desirable for hauling conditions on level German farms.

The relation of skein gather and wheel dish is expressed by a formula, in which is the angle between the spoke and a line at right angles to the center line of the skein equals the angle between the center line of the skein and the center line of the main axle plus the angle between a spoke exactly at the bottom side of the wheel and a line perpendicular to the center line of the main axle.

Present practices call for a skein gather for ordinary loads varying from less than one to about 3 degrees, or from 1.6 to 5.25 per cent of the skein length. Heavier loads call for a gather of from 7 to 13 per cent. A too great a gather results in excessive friction on the thrust bearing, while a too small gather does not make proper use of the thrust bearing on rough roads. Experience has shown that the best construction consists of a slightly conical thimble with a medium gather. Similar rules prevail for wheel dishing.

Formulas are developed for the design of wheels having the proper dish and of axles and skeins with the proper gather for specific loads, track widths, and wheel diameters.

The Bulking of Moist Sands: Effect of Phenomenon on Strength and Yield of Concrete, A. A. Levison. (U. S. Department of Agriculture, Public Roads, Washington, D. C., 5 (1924), No. 5, pp. 21-23, figs. 5.) Experiments on the bulking of moist sands and its effect on the yield and strength of concrete are briefly reported.

The results showed that with gravel concrete the yield per unit volume of coarse aggregate exceeds that of trap rock by about 6 per cent. The decrease in yield due to the omission of coarse aggregate between 0.25 and 0.75 inches in size was from 3 to 4 per cent, while that due to using the nominal volume of damp sand without a correction for bulking was 7 per cent for a 1:2:4 mix and 8.5 per cent for a 1:2:3 mix. The decrease in yield due to using damp sand without a bulking correction and omitting the smaller sizes of coarse aggregate was 12 per cent.

A 1:2:4 mix made with dry sand averaged 14 per cent stronger than mixes made with the same volumes of damp sand. A 1:2:3 mix made with dry sand averaged 3 per cent weaker than mixes made with the same volumes of damp sand. The omission of the smaller sizes of coarse aggregate resulted in a decrease in strength of from 12 to 14 per cent. Cylinders of a 1:2:4 mix made with dry sand and well graded coarse aggregate averaged 17 per cent stronger than those made with damp sand and poorly graded coarse aggregate. With a 1:2:3 mix this difference in strength was 12 per cent in the same direction.

Volume Change a Measure of Alkali Action, D. G. Miller. (U. S. Department of Agriculture, Public Roads, Washington, D. C., 5 (1924), No. 4, pp. 12, 13, 17, figs. 4.) Studies conducted by the department of agriculture of the University of Minnesota, the Minnesota Department of Drainage and Waters, and the U. L. Bureau of Public Roads on the effect of alkali action on concrete has indicated by changes in length of test specimens are briefly reported.

The results indicate that any appreciable increase in length of test specimens is indicative of loss of strength, since test cylinders stored in distilled water not only showed no tendency to expand but in many cases slightly contracted. Studies of the relative effects of alkali solutions of different strengths on test cylinders have shown that the destructive effect of a 4 per cent solution is not much greater than that of a one per cent solution, although for solutions of below one per cent the action is approximately proportional to the strength of the solution.

Belt Speeds for the Electrical Driving of Threshing Machines, L. Riefstahl. (Technik in der Landwirtschaft, Berlin, 4 (1923), No. 10-11, pp. 160-162, figs. 2.) Data from various sources on belt and pulley speeds for threshing machines operated by steam engine, gas tractor, and electric motor are reported and discussed.

The necessity for the standardization of belt speeds for threshers of different capacities is emphasized as a basis for the proper design of electric motors for this work. It is concluded that the belt speed should never be less than 16 meters (52.5 feet) per second for ordinary machines, and for the larger machines, requiring thirty and more than 40 horsepower, speeds of 18 and 20 meters per second, respectively, are desirable. In order to make a motor capable of operating threshers available for other belt uses on the farm, the necessity of standardizing motor belt pulleys for different jobs is considered evident.

News Section

Report of Nominating Committee

THE Nominating Committee of the American Society of Agricultural Engineers has made its report, placing in nomination candidates for election to the several offices, to take office immediately following the annual meeting of the Society to be held in June, 1925, and to serve for one year.

On or about March 1 the Secretary will prepare and mail secret letter ballots on candidates for several offices to all voting members. The intervening period between the time of the publication of this report and the sending out of the secret letter ballots to members is to allow special nominating committees to make additional nominations for the various offices as provided in the Constitution.

The list of candidates nominated for the several offices are as follows:

For President

F. A. Wirt, J. I. Case Threshing Machine Company, Racine, Wisconsin.

For First Vice-president

John Swenehart, Department of Agricultural Engineering, University of Wisconsin, Madison, Wisconsin.

Ivan D. Wood, Department of Agricultural Engineering, University of Nebraska, Lincoln, Nebraska.

For Second Vice-president

W. B. Clarkson, King Ventilating Company, Owatonna, Minnesota

M. A. R. Kelley, Division of Agricultural Engineering, U. S. Department of Agriculture, Washington, D. C.

For Treasurer,

Raymond Olney, Mount Clemens, Michigan.

For Member of Council

F. N. G. Kranich, Timken Roller Bearing Company, Racine, Wisconsin.

C. O. Reed, Department of Agricultural Engineering, Ohio State University, Columbus, Ohio.

Arnold P. Yerkes, International Harvester Company, Chicago, Illinois.

For Nominating Committee

William Boss, Department of Agricultural Engineering, University of Minnesota, St. Paul, Minnesota.

F. W. Duffee, University of Wisconsin, Madison, Wisconsin.

W. G. Kaiser, Portland Cement Association, Chicago, Illinois.

Dan Scoates, Texas A. and M. College, College Station, Texas.

O. B. Zimmerman, International Harvester Co., Chicago, Illinois.

Activities of the Pacific Coast Section

A VERY enthusiastic and aggressive group of agricultural engineers attended the first meeting of the Pacific Coast Section of the American Society of gricultural Engineers held December 12 in the Stephens Union on the campus of the University of California at Berkeley. On account of an irrigation meeting at Sacramento at the same time the attendance at the meeting was reduced to some extent.

One of the features of the meeting was Robert Sibley's account of his recent trip to the World Power Conference at London. He described some of the European customs and practices and discussed at some length the uses of electrical energy in the many European countries which he visited, a farm near London being featured for its extensive use of electricity. He was impressed with the thoroughness of European investigations in the field of rural electrification. His observation is that much more extensive use is made of electricity on the farms of California than anywhere abroad, but that the Europeans are proceeding with greater caution, basing their development on careful research. Mr. Sibley also pointed out in a graphic manner that the total annual consumption of electric energy for the United States was 60 billion kilowatt-hours while the consumption for all other countries together was a little under 50 billion kilowatt-hours.

P. E. Holt, chief engineer of the Holt Manufacturing Company, related many interesting experiences in the engineering development of the "Caterpillar" tractor. Pictures of the early type of steam and gas tractors proved of considerable interest. Mr. Holt told of the effort his company had made to build wheels wide enough to keep their heavy steam tractors on top of the soft peat land of the Delta district of California, which was being developed at that time. The early "Caterpillars" were large tractors used to pull plows and combined harvesters in the grain fields of the Pacific Coast states. Later the smaller sizes were developed for the orchards and vineyards, and then the military and industrial types. Mr. Holt emphasized the need for investigational work in farm machinery to develop suitable implements or methods for utilizing the tractor most efficiently on farms. "There are great possibilities in the power-take-off," he stated. The pressing need for reliable data on the power requirements of power operated machines offer a fertile field of investigation for agricultural engineers.

Prof. B. D. Moses, executive secretary of the California Committee on the Relation of Electricity to Agriculture, made a report reviewing the activities of that committee in the state.

Announcement was made at the meeting of another meeting of the Pacific Coast Section to be held in Los Angeles May 29, 1925. At that meeting David Weeks, of the division of rural institutions, University of California, who has made extensive studies of the agricultural development of reclaimed areas, will present a paper on the Spanish Springs project in Nevada. Max E. Cook, agricultural engineer of the California Redwood Association, will present a paper on farm buildings. A business meeting of the section will be held in the afternoon and the evening meeting will be devoted to papers and discussions.

At the meeting definite plans were made for interesting members of the Pacific Coast Section in writing articles and securing suitable pictures for AGRICULTURAL ENGINEERING, the journal of the Society. Various plans for the 1926 annual meeting of the Society, which in all probability will be held in California, were discussed. The committee will collect information and prepare a report on this matter for presentation at the Los Angeles meeting.

Research At V. P. I.

ACCORDING to information received from Prof. C. E. Seitz, head of the department of agricultural engineering at the Virginia Polytechnic Institute, an extensive research program in agricultural engineering is being gotten under way at that institution. It has been realized by Prof. Seitz and his associates that, if the department is to continue making progress, the development and progress of research is essential. One of the principal research projects being conducted is an economic study of tile drainage in Virginia, which consists of field investigation of approximately one hundred farm drainage systems that have been installed in the state during the past few years. This project involves a study of the engineering features and the principal causes of success or failure, as well as the economics of drainage.

Another important project is the utilization of electricity in agriculture, being a field study to determine the optimum economic uses of electricity in agriculture. A rural line, 4.7 miles in length, has been constructed to serve approximately thirty farms. Four of these farms have been selected and will be completely electrified for the purpose of the investigation.

Somewhat along the same lines are two other projects: (1) The present status of the use of electricity in agriculture and (2) an economic study of farm water power plants. The former is an investigation covering the survey of the present available sources and uses of electric power in Virginia, dealing with the application of electricity to agriculture, its geographical distribution, etc. The second is an investigation to obtain reliable information on the method, cost, and uses of power plants on the farms of the state.

A research project on spray equipment consists of a study of spray equipment, with special reference to the effects of the size of nozzle orifices and pressure on atomization of spray material and the resultant effects on (1) covering power of the spray material, (2)penetration power of the spray material, (3) carrying power of the spray material, (4) economy of spray material, (5) impaction force of spray material, and (6) injury to fruit and foliage.

A study of the operation of hydraulic rams working under practical conditions is also being made to (1) test the efficiency of all makes of rams used in the state, (2) determine the advantage of standpipes, (3) find the minimum flow necessary to operate all the smaller rams, working under practical conditions, (4) get the most efficient relations between fall and length of drive pipe and between fall and elevation, (5) get data on friction as applied to the delivery pipe, (6) experiment with different sizes of drive pipes on the same size ram, and (7) get the most efficient number of strokes per minute for the different heights of fall and lengths of drive pipe.

An investigation of farm water power plants with special reference to the economy of such installations is also being made.

The principal extension projects that have been undertaken this year are drainage, terracing, water supply and sanitation, water power, and farm buildings.

There are at present thirty-one students enrolled in the agricultural engineering course at V. P. I., and four graduate students. Ten men were graduated in agricultural engineering at that institution last June.

Minnesota's New Bulletins on Drainage

THE Minnesota agricultural experiment station has just issued the first two of a series of bulletins on various phases of the farm drainage problem, which represent very thorough and extensive research on the part of the author, H. B. Roe, professor of drainage and head of the drainage section of the division of agricultural engineering at the University of Minnesota. They are Bulletin No. 216, "Farm Drainage Methods—Survey and Design", and Bulletin No. 217, "Farm Drainage Methods—Construction". The bulletins are of a semi-technical character based on investigational work and experience at the Minnesota station for the past seventeen years. Agricultural engineers and the lay public interested in the development of intensive farm drainage will find many things of interest in these bulletins. The bulletins are free on request, but the edition published is a limited one and those agricultural engineers who have special interest in drainage should make request for copies early.

To Present Program on Rural Electrification

AT the annual convention of the Electric Section of the Wisconsin Utilities Association, to be held at the Hotel Pfister, Milwaukee Wisconsin. February 5 and 6, the entire afternoon of February 6 will be devoted to problems of rural electrification.

At this meeting R. G. Walter, of the Wisconsin Power & Light Company, and chairman of the rural service committee of the association, will present a report on the activities of his committee. Prof. F. W. Duffee, of the department of agricultural engineering, University of Wisconsin, will present a report on the Ripon experimental farm electric service line. Prof. E. A. Stewart, of the University of Minnesota, and project director of the Red Wing (Minnesota) experimental farm line, will tell about what has been accomplished in that field laboratory of rural electrification. R. H. Rogers, of the General Electric Company, will present a paper on the application of electric heating and power to rural service.

These formal papers and reports will be followed by a general discussion by all present of the problems connected with rural electrification.

G. C. Neff, of the Wisconsin Power and Light Company, is president of the Wisconsin Utilities Association.

Agricultural Standardization in Russia

THE standardization movement in Russia, now under way for about a year, has developed an organization and is now actively at work under the leadership of a commission appointed by the Supreme Council of National Economy of the Soviet Republic. The Russians are anxious that their standardization work shall be correlated with that going on in the other seventeen industrial countries of the world that are active in industrial and engineering standardization work and to that end are giving careful study to the movement.

A problem which is of great importance in that country and in countries which export farm machinery to Russia, is that of the standardization of agricultural machinery and implements. This project is being carried on by the commissariat of agricultural in cooperation with the commission mentioned and with the cooperative and state stores dealing in agricultural machinery and implements. Among the members of the commissariat, all of whom are specialists in their field, is Prof. D. D. Arzybaschev, well known in this country as an agricultural machinery expert. He is the author of a book, published in 1923, on standardization of agricultural machinery.

Personals

F. A. Wirt, manager of sales promotion of the J. I. Case Threshing Machine Company and editor of "The Case Eagle", the company's dealer house organ, has recently been promoted to the position of advertising manager of that company.

A. S. A. E. Employment Service

This service, conducted by the American Society of Agricultural Engineers, appears regularly in each issue of Agricultural Engineering. Members of the Society in good standing will be listed in the published notices of the "Men Available" section. Non-members as well as members, are privileged to use the "Positions Available" section. Copy for notices should be in the Secretary's hands by the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. No charge will be made for this service.

Men Available

AGRICULTURAL ENGINEER, 1923 graduate of Kansas State Agricultural College in agricultural engineering, desires to make a change. Work along engineering lines is preferred. Address M. S. Cook, 5406 Ferdinand Street, Chicago, Illinois. MA-121.

AGRICULTURAL ENGINEER with experience on large farms with all kinds of machinery and equipment wants position with manufacturer of farm equipment. MA-122.

AGRICULTURAL ENGINEER wants position with contractors doing work in farmstead planning and building. MA-123.

AGRICULTURAL ENGINEER open for position as sales engineer, salesman, advertising writer, or agricultural propagandist. Past experience with large agricultural firms. MA-124.

Positions Open

AGRICULTURAL ENGINEER equipped with good training and experience in agricultural engineering, preferably familiar with New England agriculture, is wanted by state agricultural experiment station in one of the New England states, to take charge of experimental work on rural electrification projects. Write the Secretary of the American Society of Agricultural Engineers.

AGRICULTURAL ENGINEER, who is capable executive anr familiar with southern conditions, wanted to take charge of agricltitural engineering department in a southern land-grant college. The position pays a salary of $3,000 a year to start, and carries the rank of professor and head of the department.